THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE III. VOL. III.

No. IV.—APRIL, 1886.

ORIGINAL ARTICLES.

I.—On Some Fossil Ostracoda from Colorado.

By Prof. T. Rupert Jones, F.R.S., etc.

(PLATE IV.)[1]

In December last Dr. C. A. White, Palæontologist to the U.S. Geological Survey, sent me a small packet of siliceous Ostracoda, obtained by dissolving in dilute acid some pieces of an impure limestone from the Jurassic "*Atlantosaurus* Beds" near Cañon City, Colorado. These strata are of freshwater origin; and, besides the wonderful Dinosaurian and Mammalian fauna, which Prof. O. C. Marsh has published, they contain, Dr. White informs me, *Unio*, *Limnæa*, *Planorbis*, and *Valvata*, all of modern types. In the impure limestone with Ostracods, and in associated layers, these Gasteropods are found also in a silicified state, and the Dinosaurian fossils occur both above and below them.

In January of this year I received also from the U.S. Geological Survey, through Dr. A. C. White's kind agency, a piece of the hard limestone itself, for the examination of the microzoa not treated with acid. Some fragments, carefully crushed, yielded free specimens, but not so many nor so perfect as those obtained by acid-solution of similar pieces. By careful manipulation my friend Mr. C. D. Sherborn succeeded in finding some that showed traces of ornament by the presence of the whitish matrix (siliceous) in rows of little pits and in slight furrows similar to those on the Purbeck *Metacypris Forbesii*. Consequently these little siliceous organisms are not all internal casts, but some are perfect carapaces.

On the examination of thin sections and decalcified slices, many sections of Ostracodous bivalved carapaces are recognized, also crushed valves and numerous fragments. The test is often apparent, replaced by silica. No limbs nor internal organs are visible within the whole (bivalve) tests; only groups of brown granules, arranged somewhat concentrically, as also in the neighbouring siliceous infillings of *Limnæa*, and other Gasteropods, and in the chalcedonic (agate-like) infillings of rifts and other spaces in the matrix. In some instances the carapace-valves are absent, and the first inside layer of chalcedony imitates the shell. On being decalcified, a slice

[1] This Plate was drawn with aid of a grant from the Royal Society for the illustration of fossil Ostracoda.

loses much of its brownness; but some of the silica still retains a brown tint.

1. Metacypris Forbesii, Jones. Plate IV. Figs. 1*a*, 1*b*, 1*c*.

M. Forbesii, Jones, Quart. Journ. Geol. Soc., vol. xli. 1885, p. 345, pl. 8, figs. 11–16 (including var. *verrucosa*); *M. Forbesii*, Jones, in Bullet. U.S. Geol. Surv. February (?), 1886.

Comparing our Figs. 1*a*, 1*b*, 1*c*, of the American *Metacypris* with figs. 13 and 15 of plate 8 referred to above, we see no special difference except that the antero-dorsal (nuchal) constriction is stronger in the former two figures, and the valves are rather more swollen in their posterior moiety.[1] The siliceous specimens figured do not show the ornament seen in their English representatives; but some that have been beaten out (not separated by acid) show the characteristic ornament, as stated above. Not rare.

For the proportions of this and the other species, see the Table at the end.

2. Metacypris Bradyi, sp. nov. Pl. IV. Figs. 2*a*, 2*b*, 2*c*.

M. Forbesii [var.], Jones, in Bullet. U.S. Geol. Survey, February (?), 1886.

"This is even longer in proportion than our most oblong form," such as fig. 11, pl. 8, Q.J.G.S. vol. xli.; and the constriction is very strong, being deep, curving forward, and reaching quite across the valve.[2] The posterior moiety of each valve is relatively less swollen than in *M. Forbesii*; but the convexity of the anterior portion is more pronounced, and more markedly defined by the transverse sulcus; and, owing to the curve of the furrow, the hinder portion has an almost round convexity. A pimple on the centre of this part, and some few elsewhere, show an analogy to the warty condition of *M. Forbesii*, var. *verrucosa*, *op. cit.* pl. 8, figs. 12 and 15. Not rare.

I propose to name this, as a distinct species, after my friend Dr. G. S. Brady, F.R.S., who first recognized the genus *Metacypris* (*op. cit.* p. 344).

3. Metacypris Whitei, sp. nov. Pl. IV. Figs. 3*a*, 3*b*, 3*c*.

Metacypris, sp. Jones, in Bullet. U.S. Geol. Survey, February (?), 1886.

"This form is narrow [relatively], oblong, and compressed; and bears a distant resemblance to '*Cypris* (?) *conculcata*,' Jones, Quart. Journ. Geol. Soc., vol. xvi. 1860, p. 266, pl. 16, figs. 3*a* and 3*b*" (3*c*, young?). Valves oblong, nearly straight above and below, almost equally rounded at the ends; compressed in front, thicker behind. Impressed at the anterior third with a shallow sulcus, and with a faint hollow near the anterior hinge. Edge-view narrow-ovate, sharp in front, obtuse behind, and somewhat undulate at the sides by reason of the slight depressions. Not rare.

[1] Some of the English specimens are more constricted than shown in the figures and descriptions, *op. cit.* p. 345.

[2] The transverse sulcus impressed on or near the mid-dorsal region of each valve is characteristic also of *Limnicythere* and occurs in some other recent Ostracods of estuarine and freshwater habitats, namely, *Cyprideis* (*Cytheridea*), and one *Cypris* (*C. gibba*, Ramdohr).

This species is named after Dr. A. C. White, Palæontologist of the U.S. Geological Survey, Washington, who kindly submitted these interesting Colorado specimens for my examination.

Another fossil *Metacypris* was described and figured some years ago as *Cypris strangulata*, Jones (Quart. Journ. Geol. Soc. vol. xvi. 1860, p. 187, pl. 10, figs. 73*a*, *b*, *c*, *d*, comprising probably two species), from the Tertiary beds of Central India, at Pahádsingha and Butára, both in the Province of Nagpur (*op. cit.* pp. 165, 166).

4. Darwinula leguminella (E. Forbes). Pl. IV. Figs. 4*a*, 4*b*, 4*c*.

D. leguminella (E. Forbes), Jones, Q. J. G. S. vol. xli. 1885, p. 346, pl. 8, figs. 30 and 31; and in Bullet. U. S. Geol. Surv. February (?), 1886.

It is evident that, judging from the shape and size of the carapace, we must refer these American specimens, which are not rare, to the same genus and species as determined for the similar little Purbeck-Wealden Ostracods of England and Hanover.

Darwinula Stevensoni, Brady and Robertson, lives at present in the brackish water of tidal rivers, and has been found fossil in late Tertiary deposits belonging to the Forest-bed series of Suffolk. *D. Berniciana*, Jones (Proceed. Berwicksh. Nat. Club, 1884, vol. x. p. 325), is a Lower-Carboniferous form in Northumberland, and *D.? pungens*, J. and K., occurs in the Coal-measures of Scotland. Another probable *Darwinula* is the *Cypris* (?) *Allportiana*, Jones, from the Neocomian [1] freshwater beds near Bahia, in Brazil; see Q. J. G. S. 1860, vol. xvi. p. 267, pl. 16, fig. 16.

5. Cypris Purbeckensis, E. Forbes. Pl. IV. Figs. 5*a*, 5*b*, 5*c*.

Cypris Purbeckensis, E. Forbes. Jones, Q. J. G. S. 1885, vol. xli. p. 347, pl. 9, figs. 1–6.

The figured carapace, Fig. 5*a*, corresponds with fig. 5, in pl. 9, Q. J. G. S.; and Fig. 5*b* nearly with fig. 4 of that plate, in which various forms of this species are given. It is common in the English Purbeck beds, but rare and smaller in the sample from Colorado.

6. Cytherideis Marshii, sp. nov. Pl. IV. Fig. 6*a*, 6*b*, 6*c*.

This carapace, apparently perfect (showing the translucent edges of the closed valves), approaches very near to *Cytherideis trigonalis*, Jones, Monogr. Tertiary Entom., Pal. Soc. 1856, p. 47, pl. 2, figs. 2*a*–2*h*; but the curve and slope of the front margin differ, this end being slightly blunter in the American form. The greatest convexity, also, is rather ventral than along the middle. Rare.

This species is named after the eminent palæontologist who has worked so enthusiastically and successfully in these highly interesting fossiliferous deposits of the Far West.

7. Cytheridea? atlantosaurica, sp. nov. Pl. IV. Figs. 7*a*, 7*b*, 7*c*.

An oblong, convex carapace, round-ended, with the anterior rather higher (broader) than the other end, and slightly oblique. Valves somewhat undulate, being faintly impressed in the postero-dorsal

[1] Referred to the Neocomian by Dr. A. C. White in a work prepared by him for publication by the Brazilian Government.

region. The convexity is greatest along the ventral region, causing this part to swell out a little beyond the ventral margin. Edge view oval with sharp ends; end view short-ovate, acute above, broad below. Rare.

This distantly resembles the smooth variety of *Cytheridea torosa* (Jones), Monogr. Tert. Entom. 1856, p. 21, pl. 2, fig. 1*e*; var. *teres*, Brady (Trans. Linn. Soc. 1868, vol. xxvi. p. 425, pl. 28, figs. 7–12; Ann. Mag. Nat. Hist. 1870, ser. 4, vol. vi. pp. 21, 22, *note*; Monogr. Post-Tert. Entom., Pal. Soc. 1874, p. 178, pl. 7, figs. 1 & 2). The anterior hinge, however, is more definite, though not prominent, the shape is rather more truly oblong, and the sub-medial impression is not so strong. As I have not seen an interior of a valve, I cannot say if this American species belongs to *Cytheridea* or to *Cytherideis*.

Table of Proportions.

	Length.	Height.	Thickness.
Metacypris Forbesii, Fig. 1	15	9	11
M. Bradyi, Fig. 2	18	10	10
M. Whitei, Fig. 3	18	9	8
Darwinula leguminella, Fig. 4	14	6	5
Cypris Purbeckensis, Fig. 5	13	6	5
Cytherideis Marshii, Fig. 6	13	7	5
Cytheridea ? atlantosaurica, Fig. 7	12	6	6

If these proportional numbers be divided by 15, the result will be linear dimensions in a millimètre and parts of a millimètre; the figures being magnified 15 diameters.

As the anterior extremity is placed upwards in the figures, the *height* of the valves appears as *width* on the plate.

The species Figs. 1, 2, 3, 4 are abundant; those shown by Figs. 5, 6, and 7 are rare.

EXPLANATION OF PLATE IV.

(The figures are magnified 15 diam.)

Throughout *a* is the side view; *b*, edge view; *c*, end view of the bivalved carapace.

Fig. 1. *Metacypris Forbesii*, Jones; *a*, right valve outwards.
,, 2. *M. Bradyi*, Jones; *a*, right valve outwards.
,, 3. *M. Whitei*, Jones; *a*, left valve, outwards.
,, 4. *Darwinula leguminella* (E. Forbes); *a*, right valve outwards.
,, 5. *Cypris Purbeckensis*, E. Forbes; *a*, left valve outwards.
,, 6. *Cytherideis Marshii*, Jones; *a*, left valve outwards.
,, 7. *Cytheridea ? atlantosaurica*, Jones; *a*, left valve outwards.

II.—Notes on a Collection of Fossil Fish-Remains from the Mountain Limestone of Derbyshire.

By James W. Davis, F.G.S.

I am indebted to Thos. Parker, Esq., of Oldham, for the opportunity he has afforded me of examining his large collection of fish-remains from the Carboniferous Limestone of Derbyshire. The specimens have been obtained from quarries near Chapel-en-le-Frith, in the N.W. of the county. They are for the most part in a beautiful state of preservation, though some of the more fragile specimens are only obtained with the most careful manipulation on account of their liability to fracture. The fossils are creamy-white in a light-coloured crystalline limestone matrix.

The fauna of this district affords some features of peculiar interest. There is an entire absence of fin-rays, and of the sharply-pointed conical teeth like *Cladodus*, a negative evidence of their intimate relationship where present. There are two genera of Petalodontidæ, three of the Copodontidæ, five of the Cochliodontidæ, one of *Pleurodus* and one of *Psammodus*. Of all these only one species, *Psephodus magnus*, Agass., has been previously recorded from Derbyshire. Besides *P. magnus*, the following fish-remains have been chronicled either in M'Coy's British Palæozoic Fossils, or in the Fossil Fishes of the Carboniferous Limestone series of Great Britain, in the Transactions of the Royal Dublin Society, by the present writer :—

Acondylacanthus (*Leptacanthus*, M'Coy) *junceus*, M'Coy.
Cladodus mirabilis, Agass.
Cladodus striatus, Agass.
Pristicladodus dentatus, M'Coy.
Petrodus patelliformis, M'Coy.
Deltodus aliformis, Agass.
Deltoptychius acutus, Agass.
Pœcilodus foveolatus, M'Coy.
Petalodus acuminatus, Agass.
Cheirodus pes-ranæ, M'Coy.

To this list is now added twelve species, five of which have not previously been described; they are comprised in the following descriptions, to which are added such observations as appear necessary to indicate peculiarities of form or structure.

Family Petalodontidæ, Newberry and Worthen.

Genus *Petalodus*, Owen.

Owen, Odontography, p. 61 (1840).
Davis, Trans. Roy. Dublin Soc., n.s. vol. i. p. 429 (1883).

Petalodus Hastingsiæ, Owen.

Odontography, p. 61, pl. xxii. figs. 3, 4, 5.
Davis, *l.c.* p. 493, pl. lix. figs. 16–21.

A considerable number of the teeth of this species have been found varying in size as well as in form. An average tooth apparently of full size is 0·35 inch across the crown; the height of the latter being 0·15 inch. The base is nearly double the height of the crown. Whilst agreeing generally in form with the species from the Mountain Limestone of Armagh, it differs in the greater area occupied by the imbricating ridges at the base of the crown; whilst the former possess five or six folds or ridges, the specimens from Derbyshire have nine. Some of the examples are broader across the crown, than the average tooth already named, and the height of the crown is less, very thin, and almost straight. This may be due to greater wear, the coronal surface being reduced from the normal convexity to a more or less straight edge; or, it may indicate a different species. The broad form closely resembles in some particulars the specimens of *Petalodus inequilateralis* from the Limestone of Wensleydale.

Genus *Petalorhynchus*, Agass. MS.

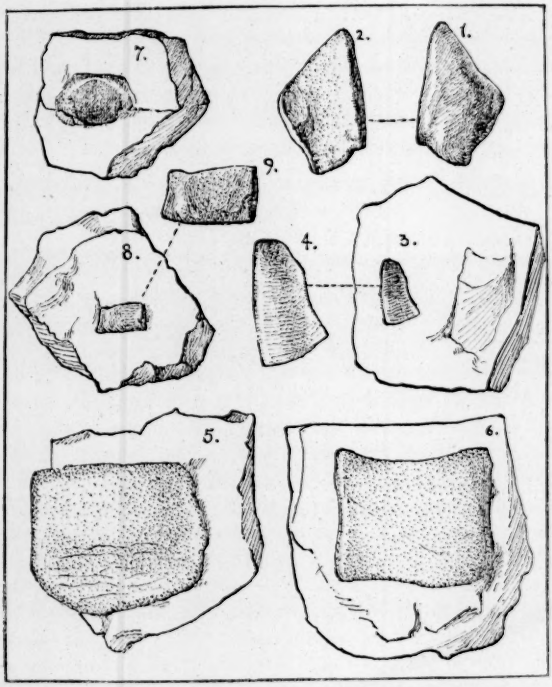
Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 516 (1883).

Petalorhynchus psittacinus, Agass. MS.

Davis, *l.c.* p. 516, pl. lxi. figs. 12–16.

Hitherto the teeth of this species have been found only in the Mountain Limestone at Armagh and the Carboniferous Series near

Glasgow. The specimens from Derbyshire present as great a variety in form as those from Armagh so far as the series extend, and there can be little doubt that the species is the same. In one or two of the best-preserved examples, the depth of the tooth only exceeds the breadth by one-fifth, and consequently is probably from the posterior part of the mouth; the sigmoidally curved folds of the ganoine, extending across the external surface at the base of the crown, are only three in number. In the species found at Armagh there are four or five imbricating folds. The beak-like cutting-edge of the crown is somewhat deeply and broadly serrated along each lateral margin in some of the specimens; in this it also diverges from the types and offers a superficial resemblance to the teeth of the genus *Ctenopetalus*. Minute vertical furrows extend from the cutting margin downwards over the anterior surface of the crown.



Palatal Teeth of Fishes from the Carboniferous Limestone, Chapel-en-le-Frith, Derbyshire. Coll. Thos. Parker, Esq.

Family Cochliodontidæ, R. Owen.

Streblodus oblongus, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 424, pl. liii. figs. 1–4 (1883).

Remains of the teeth of this species are not uncommon. They are usually detached, and owing to their extreme brittleness, and the

difficulty with which they are developed from the matrix, they are often fragmentary. An example exhibiting the series of three teeth covering a ramus of the jaw has not yet been discovered. The large posterior teeth are most commonly met with. They are much smaller in size than those of the same species from the Mountain Limestone of Armagh, generally about 0·5 inch in length and 0·3 in breadth. They possess the characteristic convolution of the genus. The enamelled surface of the crown is exquisitely and perfectly preserved, and in most instances does not exhibit much trace of being worn by attrition, from which it may perhaps be reasonably inferred that they are the teeth of a young individual.

Genus *Psephodus*, Agass, MS.

Davis, Trans. Roy. Dub. Soc. n.s. vol. i. p. 438 (1883).

Psephodus magnus, Ag.

Trans. of the Royal Dublin Society, ser. ii. vol. i. p. 439, pl. lv. fig. 1–14.

Several examples of this species have been found. They do not materially differ from the specimens described from the Carboniferous Limestone of Armagh. The largest tooth, probably occupying a median position on the jaw, is 0·85 inch in greatest diameter, more or less pentagonal in outline, the upper surface highly convex, and the under one correspondingly concave.

A second specimen consists of two teeth joined together similarly to those represented in the memoir named above, pl. lv. fig. 4, the two upper and larger teeth; the Derbyshire ones are about two-thirds the size of those from Armagh.

Teeth occur which differ from the types in some particulars. They are almost circular in form, and equally convex from all sides; their diameter across the crown is slightly less than half an inch. They may represent a different species of this genus of fossil fishes, but until a larger number of specimens have been found affording more complete evidence of its peculiar characters, it appears advisable to retain them under the above title as a variety of the old type.

A number of small helodont teeth are scattered over some of the pieces of limestone. They are small and elongated, smooth and even on the surface of the crown, without median or other prominence. They were probably connected with this or the following species of *Psephodus*.

Psephodus simplex, Davis, sp. nov. (Figs. 1, 2, p. 150).

Teeth trapezoidal in outline, longest diameter 0·8 inch. Two longest sides forming an acute angle at the apex. The two shorter ones, half the length of the longer, inclosing an obtuse angle. The surface of the crown is convex (Fig. 1), its enamelled surface covered with small punctures. The margins of the tooth are thick. The under surface (Fig. 2) forms a channel extending parallel with the long axis of the tooth, which like the under side of *Psephodus magnus*, Ag., was attached to one of the cartilaginous jaws of the fish.

The teeth comprised in this species, of which several specimens have been found, are almost identical in shape. They differ from those

of *P. magnus* in form; the latter are more or less pentagonal or rounded, whilst this species is four-sided, two being so much longer than the others as to assume almost a triangular appearance. I have ventured to distinguish the species by giving it the name *Psephodus simplex.*

Genus *Deltoptychius*, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 432 (1883).

Deltoptychius plicatus, Davis.

Quart. Journ. Geol. Soc. vol. xl. p. 628, pl. xxvi. figs. 13, 14 (1884).

Several teeth of this species have been obtained. They do not materially differ from those described in the paper referred to above, from the Yoredale Series of Wensleydale, in the possession of Mr. Horne; like them, they are readily distinguished from the type species of Agassiz, *D. acutus*, by the greater prominence of the ridges occupying the surface of the crown; the more regular and broader form; and more widely expanded outer margin. The Derbyshire specimens are slightly larger than those found at Wensleydale. They are delicately and beautifully punctate on the surface.

Genus *Pœcilodus*, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 441 (1883).

Pœcilodus Jonesii, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 442, pl. liii. fig. 20-23.

Teeth of this genus have been found. They correspond with those of the same species found at Armagh in essential characters. They are of two forms, the larger posterior tooth is about 0·5 inch in breadth, the length equalling half the breadth. The posterior portion of the tooth is broadest and is free from ridges. Its surface is considerably worn and forms a concave depression. The remainder of the crown is traversed by 7 or 8 parallel ridges. The whole is enamelled and punctate. The *second tooth* is smaller, sub-triangular in outline; its length is the same as that of the larger tooth, 0·25 inch; the greatest breadth is 0·1 in., diminishing towards the opposite extremity. Five ridges are exposed, extending transversely across the surface, separated by somewhat deep grooves. It is similarly enamelled and punctate to the posterior tooth.

The only species of the genus *Pœcilodus* hitherto recorded from the Mountain Limestone of Derbyshire is *P. foveolatus*, M'Coy (British Palæozoic Fossils, p. 639, pl. 3G). The type is in the Woodwardian Museum, Cambridge, and is unique. It is readily distinguished from the specimens in Mr. Parker's collection by its large size, narrow, elongate form, more numerous and diagonally disposed ridges, and the regular rows of puncta which run parallel with the ridges. The species, *Pœcilodus Jonesii*, named by the late Prof. Agassiz, and described in the memoir cited above, has hitherto been found only in the Limestone of Ireland. It comprises teeth of two forms originally considered by Agassiz to represent two species, but proved by specimens in the collection of the Earl of Enniskillen, now transferred to the Natural History Museum, Cromwell Road, to

belong to the same species, and to be the anterior tooth of *P. Jonesii*. In this, as in others of its principal features, the species from Derbyshire agrees; and whilst in one or two minor points it is dissimilar—as, for instance, in the greater expansion of the smooth posterior part of the larger tooth, and the fewer number of the ridges on the small one—there can be no hesitation in considering those differences as not more than varietal, and including it in the same species with the examples from Armagh.

Genus *Xystrodus*, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 447 (1883).

Xystrodus Parkeri, Davis, sp. nov. (Figs. 3 and 4, p. 150).

Several exquisitely beautiful little teeth have been found belonging to this genus. They are 0·3 to 0·4 inch in length, and 0·15 to 0·2 inch in width, sub-triangular in outline, rounded anteriorly, and expanding towards the posterior margin. Surface of the crown concavo-convex, rising on one side in the form of a ridge, depressed along the opposite one, forming a broad concave channel extending the whole of the length of the tooth, and expanding into a somewhat aliform margin, more or less sinuous in outline. The surface is enamelled, and a number of minute punctures, arranged so as to form a series of sinuously parallel ridges, extend across the tooth.

This species resembles most nearly that of *Xystrodus pulchellus*, Davis (Trans. R. Dublin Soc. n.s. vol. i. p. 450, pl. lv. fig. 24), from the Yoredale Series of Wensleydale, but may be readily distinguished by its rounded anterior extremity, less acutely triangular form, and the aliform character of the concave margin. The convex margin is rounded in this species, in *X. pulchellus* it is straight.

Xystrodus simplex, St. J. and W. (Geol. Survey of Illinois, vol. vii. p. 178, pl. viii. figs. 4, 5, 1883), is a larger tooth than the one now described, but is similar in form. It may be distinguished by the more acute angle formed by the lateral margins and its point of inrolment being more distinctly developed. The punctæ on the surface are without arrangement into ridges. Messrs. St. John and Worthen consider that the genus *Xystrodus* is closely allied if not identical with that of *Tomodus*, Agass. They remark, "While we have not the data necessary for carrying the comparisons to a final conclusion, we are much impressed by the intimate resemblances which subsist between the present genus and *Tomodus*, Agass. A series of careful sketches of authentic examples of *Tomodus convexus*, Agass., from the Mountain Limestone of Bristol, England, and which were kindly submitted to us by Lord Enniskillen, show this relationship in a striking manner. The genus *Tomodus*, indeed, appears to be a *Xystrodus* in all save the arrangement of the punctæ in parallel transverse lines; and in the latter respect we find a close, though not absolute agreement, in the initial species occurring in the American Carboniferous species *X. simplex*" (*op. cit.* p. 177). It was in 1859 that the late Professor Agassiz, whilst visiting the Earl of Enniskillen, took the opportunity to examine and arrange the magnificent collection of Carboniferous Limestone fish-remains which

were then located in the Florence Court Museum. Amongst others, the large, thick, massive, triangular and convolute teeth from Bristol. They are one and a quarter inch in length and nearly half an inch in thickness; the surface, convex from back to front, as well from side to side, almost globose. These were named *Tomodus convexus*. The type specimens are figured in the Trans. Roy. Dublin Society (n.s. vol. i. pl. lv. figs. 15–18). The teeth assigned to the genus *Xystrodus* are medium or small in size, of a triangular form, much elongated, slightly convoluted, and more or less acutely pointed anteriorly. The crown does not present the bold convexity characteristic of *Tomodus*, but is comparatively flat, one side of the crown being raised, the other depressed. *Xystrodus striatus* and *X. angustus*, the Agassizian types, are also figured in the memoir cited above (pls. lv. figs. 7–10 and pl. lv. figs. 19–21). The former was described by Prof. M'Coy under the name *Cochliodus striatus* (Brit. Palæozoic Fossils, p. 624, pl. 31, fig. 27). The group described by Messrs. St. John and Worthen, of which *Xystrodus simplex*, already mentioned, may be taken as the type, have all the characters of that genus, and appear to be closely related to the British species; but there is no evidence with which the writer is acquainted which demonstrates that either the British or American representatives of the genus are generically related to *Tomodus*.

In recognition of the services rendered to palæontological science by Mr. Parker, I have ventured to distinguish this species by appending to it his name.

Family Copodontidæ, Davis.

Genus *Mylacodus*, Agass.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 480 (1883).

Mylacodus variabilis, Davis, sp. nov. (Figs. 5, 6, p. 150).

Teeth trapeziform, length 0·7 inch, breadth 0·9 inch. Crown of at least two different forms, in each the surface is more or less level, slightly convex in central part between the sides, with a sigmoidal curvature in the opposite direction, the posterior and lateral margins are a little raised, inclosing a shallow depression, enamelled, and covered with minute, and in some cases scarcely distinguishable, pustulations. Anterior margin of first tooth straight, laterally more or less straight, slightly diverging to the rounded posterior margin. Angles rounded. *Second tooth*, anterior margin concave; may have been attached to the posterior margin of the first; antero-lateral angles acute, not rounded; lateral margins straight or slightly concave, posterior margin slightly convex, postero-lateral angles slightly rounded. Base not well exposed, mostly hidden in the matrix. Part exposed 0·15 inch in thickness, porous, thinning out towards the margin of the crown, with the upper surface of which it forms an acute angle.

Two species of *Mylacodus* have been described in the Trans. of the Royal Dublin Society, both from the Carboniferous Limestone of Armagh, in Ireland; the types are in the Enniskillen Collection at

the new Natural History Museum. From *M. quadratus*, Agass., this species may be distinguished by its greater breadth, straight anterior, and rounded posterior margins. The second tooth is readily distinguished by its form; and both are less distinctly punctate than in *M. quadratus*. The coronal surface of *Mylacodus sesamini*, Agass., is uniformly rugose, and the lateral depressions near the margin are deeper and more extensive. The form of the crown is that of a truncated cone as compared with the broad expansion of the species now described, which it is proposed to distinguish as *Mylacodus variabilis*.

Genus Rhymodus, Agass. MS.

Davis, Trans. Roy. Dublin Society, n.s. vol. i. p. 473.

Rhymodus convexus, Davis, sp. nov. (Fig. 7, p. 150).

Teeth: length 0·25 inch, breadth 0·45 inch. Crown, median portion uniformly convex, with depression on each side, lateral extremities raised into prominent ridges; surface enamelled; central part considerably worn by attrition, beautifully punctate, without definite arrangement. Anterior and posterior margins similar; central part rounded, with a depression, corresponding to the one across the surface, on each side. Antero-lateral angles produced, slightly rounded; opposite ones similar. Base not exposed.

This species differs from *Rhymodus transversus*, Agass., and *Rhymodus oblongus*, Davis, in the form of the coronal surface. In each of the species named there is a decided concavity in the median part of the anterior margin. In this species the anterior margin is convex. The aliform processes of the crown as well as the root, which are prominent in the two forms previously described, are not largely developed in this species. Whilst differing in specific details from the forms of *Rhymodus*, the transversely oblong form, prominent convex crown with lateral depressions and raised margins, are generic characters sufficiently distinct to leave no doubt as to its relationship with that genus. Having reference to its especially rotund coronal surface, the name *Rhymodus convexus* is suggested to distinguish the species.

Genus *Characodus*, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 474.

Characodus minimus, Davis, sp. nov. (Fig. 8, p. 150).

Teeth trapezoidal in outline, small size; anterior margin 0·2 inch in length, posterior one 0·25 inch; length 0·12 inch. Crown from front to back convex; laterally, slightly convex, the middle portion worn by attrition and somewhat depressed. The surface is covered with enamel, and minutely punctate where unworn. All the margins are straight. The base is hidden by the matrix, but appears to be the same size as the crown.

This tooth approaches most nearly to the generic characters possessed by the genus *Characodus*; it differs from the species hitherto described as *C. angulatus*, Ag., and *C. cuneatus*, Ag. (Fossil Fishes of the Carb. Limestone Series of Great Britain, Trans. Royal

Dublin Society, ser. ii. vol. i. p. 475, pl. lviii. figs. 19, 20, and 21), in the absence of a prominent lateral border on each side of the coronal surface. In the place of this the borders are more or less depressed, except midway between the anterior and posterior angles, where a minute projection forms an angular prominence. This species in its form appears to hold an intermediate position between the two named above; whilst its margin and angles are equally regular with those of *C. cuneatus*, it possesses the elongated form of *C. angulatus*.

Family Psammodontidæ, L. G. de Koninck.

Genus *Psammodus*, Agass.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 459 (1883).

Psammodus rugosus, Agass.

Poissons Fossiles, vol. iii. p. 111, pl. xii. figs. 14-18; pl. xix. fig. 15 (1833).

Several teeth of this species have been found: they do not differ from those of other localities, examples of large size are not uncommon. A specimen, of which only a portion is preserved, is 1·1 inch in breadth, a portion of the length only remains. It differs from the ordinary form in the sigmoidal curvature of the surface of the crown from back to front, one portion being depressed and concave, whilst the other is broadly convex, the latter much worn by attrition. The margin of the convex side forms an acute angle with the under surface of the base.

Genus *Pleurodus*, Agass. MS.

Davis, Trans. Roy. Dublin Soc. n.s. vol. i. p. 458 (1883).

Pleurodus Woodi, Davis.

Davis, *l.c.* p. 458, pl. lix. figs. 12–15.

About a score of teeth of this species have been found. They are extremely interesting because they extend the vertical distribution of the genus downwards from the Yoredale beds of Wensleydale to the thick-bedded Lower Limestone of Derbyshire. The type-species, *P. affinis*, was obtained from the Coal-measures, and named, but not described, by M. Louis Agassiz. The same author also named a second species, *P. Rankinii*, from the Coal-shales of Northumberland. In 1870 a specimen was discovered at Newsham, near Newcastle-on-Tyne, which was described by Messrs. Hancock and Atthey in the Trans. of Northumberland and Durham, vol. iv. pt. ii. p. 408, pl. xv. So much of the fish was preserved that its form could be identified. The length of the head and body was 3 inches, the breadth across the thorax 2 inches. The body was covered with mosaic-like tubercles, the tail was not preserved; a spine was inserted immediately behind the thorax, five-eighths of an inch in length, laterally compressed, straight, broad at the base, tapering rapidly to a point. The mouth was large, and there were apparently three or four teeth on each ramus of the jaws. The bones were cartilaginous throughout.

The teeth of *Pleurodus Woodi* indicate a fish about double the size of the one from the Newsham Coal-shales; and, judging from a

comparison of the size of the teeth, about half the size of the *Pleurodus affinis*, Agass., also from the Coal-measures. The teeth may be distinguished by the deep transverse ridges and the absence of widely expanded lateral margins, as well as their elongate form. The specimens described in the Transactions of the Royal Dublin Society from the collection of the late Mr. Wood, of Richmond, were tabulated as having been found in the Mountain Limestone of Richmond, in Yorkshire. I have since found that they were from the Upper Yoredale beds near Leyburn, the same locality from whence the collection of Mr. Horne was obtained; consequently Mr. Parker's specimens from Derbyshire are the only ones which have been found in the Lower Limestone. An example of the spine of the fish has not been found; the teeth do not differ in any appreciable degree from the types, and they are probably the same species.

Insertæ sedis.

A large number of small palatal teeth have been found associated with those already described. They are of varied forms, usually more or less elongated, sometimes of uniform width and even and smooth on the surface; in others, the median portion is raised and gibbous, the lateral extremities depressed and attenuated in width. The under-surface is devoid of basal or root-like extension, and is frequently more or less concave, thus conforming to the convexity of the crown. They are enamelled and covered with pustulations or punctations where the surface has been worn.

Many of these small teeth are probably immature examples of species already described; others may have been associated with them in different portions of the jaws, whilst it is possible that some may be distinct and independent species. It is considered advisable for the present to await the advent of other examples which shall render the determination of their affinities and relationships somewhat less problematical.

III.—On the Occurrence of Undisturbed Spots in Earthquake-shaken Areas.[1]

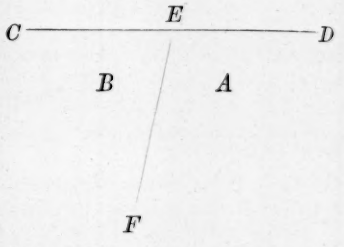
By Charles Davison, M.A.,
Mathematical Master at King Edward's High School, Birmingham.

ONE of the most important discoveries in Seismology is that which proved the close connexion in position between earthquake-centres and lines of fault, leading up to the view that the earthquake is an effect and not a cause of fault-formation. It may be the momentary result either (1) of the sudden fracturing of the earth's crust, or (2) of the impulsive friction that must accompany the relative displacement of the rock-masses adjoining the fissure. Now, earthquakes are frequent at places where faults are already advanced in the process of formation. They also recur continually at one and the same place along a line of fault, the number felt in

[1] A note read before the Birmingham Philosophical Society on March 11, 1886.

any area being often greatly in excess of the number of faults beneath that area. Hence, it follows that the majority of non-volcanic earthquakes must be due rather to the individual slips which are the elements of a great displacement than to the repeated fissuring of the earth's crust. On this view, then, the earthquake is but an incident in terrestrial evolution, and has no further connexion with the formation of mountain-chains and continents than the creaking of an unoiled wheel with the motion of a railway train.

First, let us take the case of an earth-crust homogeneous and of equal elasticity in all directions. Let *E F* represent a section of a fault or fissure, and *C D* the surface of the earth, and let us call the rock-masses on either side the fissure *A* and *B*. Now suppose *B* to be slightly, but suddenly, lowered relatively to *A*. Then the particles of *A* at the surface of the fissure will by impulsive friction be drawn sharply downwards. Similarly, those of *B* at the surface of the fissure will be drawn upwards. Hence, the earth-waves in the two rock-masses will start in opposite phases of vibration. At a distance from the fault this difference will not much affect the character of the earthquake-motion; but along the line of fault, every particle, being urged upwards and downwards equally, will remain at rest; and in the immediate neighbourhood of the line of fault, or its continuation, the disturbance will be less violent than it otherwise would be, owing to partial interference by the spreading of either earth-wave in the adjoining rock-mass.



Returning to the case of the earth-crust as it actually is, heterogeneous and discontinuous in all directions, we find the problem somewhat less simple. We have here to guide us the numerous observations of earthquakes in Japan and other places, and, to a certain extent, the seismic experiments of Prof. Milne and Mr. Gray. These lead us to infer that absolute rest along a line of fault must be a most improbable occurrence, owing to the great irregularity of the surface rocks. Still, we may believe that, in many earthquakes, the disturbances will be less violent along, and in the neighbourhood of, the line of fault, than in other parts of the disturbed area; and that in earthquakes of moderate intensity, the motion may be so slight as to be imperceptible to observers unpractised or without instrumental assistance. Evidently, also, the further away a place is from the spot where the fault-slip occurs, the less likely will it be for the earthquake-waves to interfere there.

The Scottish earthquake of November 28, 1880, furnishes a good example of these considerations. It occurred at 5·40 P.M., after the hour of sunset, and therefore at a time when all the lighthouse-keepers must have been on watch. Mr. C. A. Stevenson, who has

studied this earthquake,[1] mainly from the reports of lighthouse-keepers, shows that its epicentrum was in the neighbourhood of the island and lighthouse of Phladda, and therefore at a place on or close to the great fault which traverses Scotland in a south-westerly direction from Inverness. In all probability, the shock was caused by a slip of this fault, some distance below Phladda. On the map illustrating Mr. Stevenson's paper are marked, not only the places where the shock was distinctly felt, but also those where it is expressly stated that no shock or tremor was observed. A glance at this map suffices to show that, along the line of fault, no shock was noticed at the five places nearest the epicentrum, while at two more distant places in Scotland, and again, in the opposite direction on the coast of Ireland, the earthquake was distinctly felt.[2]

In the same manner, the following well-known instances may perhaps be accounted for, though the facts are too few to admit of circumstantial proof[3]—the sparing of a solitary house at Radicina during the Calabrian earthquake of 1783, while the rest of the town was entirely levelled; the phenomenon described by Humboldt, when the earthquake is said by the Andean natives to "form a bridge," being felt in two near but separated areas, and hardly at all in that between; and, lastly, a somewhat similar instance mentioned by Darwin as occurring during the Concepcion earthquake of 1835.

IV.—On the Waterworks at Goldstone Bottom, Brighton.

By W. Whitaker, B.A., F.G.S., Assoc. Inst. C.E.

Communicated by permission of the Director-General of the Geological Survey.

THESE works were at first only supplementary to the Lewes Road Works, on the east; but now are the chief source of supply. They were begun in 1865, and are placed in a hollow in the Chalk, in open ground at the north-western edge of Brighton. This hollow, the bottom of which, I am told, is 30 feet below the lowest part of its rim, is perhaps in itself an evidence of the existence of underground water, being due, most likely, as is usually the case in limestone-districts, to the dissolving away of the rock by underground water and to the consequent sinking-in of the surface. It is an analogous occurrence to the Meres of Norfolk, except that these are generally more or less filled with water, whilst Goldstone Bottom is quite dry at the surface. I may mention that at the time of my visit there was so thick a fog that it was impossible to see the hollow.

The Brighton Waterworks are perhaps the best example of the method to be employed in getting a very large supply from the

[1] "The Earthquake of 28th November, 1880, in Scotland and Ireland," Edinburgh Roy. Soc. Proc., vol. xi. pp. 176–187.

[2] It should be mentioned that at two other places near Phladda, and not on the line of fault, the earthquake passed unnoticed.

[3] Dolomieu, "A dissertation on the Earthquakes in Calabria Ultra, which happened in the year 1783," Pinkerton's Voyages and Travels, vol. v. p. 290.—Humboldt's Personal Narrative, vol. iv. p. 21.—C. Darwin, "On the Connexion of certain Volcanic Phenomena in South America, etc.," Geol. Trans. second series, vol. v. pp. 605–6.

Chalk, and I was therefore glad to be able to accept the invitation of the Chairman of the Waterworks Committees and of the Engineer, Mr. Edward Easton, to visit the Goldstone Bottom Station on December 6th, 1884, when, under circumstances not likely to occur again for some time, the party, of which I was one, was able to go down into the actual source of supply and to examine it thoroughly.

For the history, engineering details, and general account of the waterworks, the reader is referred to the papers by Mr. Easton in the Report of the British Association for 1872, pp. 395—400, and in the Transactions of the Brighton Health Congress, 1881, pp. 48–56, with three plates.

At Brighton the water is got from the Upper Chalk by sinking shafts down to about low-water-level, and by then driving galleries, or small tunnels, more less at right angles to the dip of the beds, so as to cut the fissures along which water flows in its passage from the higher ground on the north to the sea. The present supply is plentiful; but the Corporation have looked well ahead, and took advantage of a late dry season, to extend these tunnels and so to get a future increase (at the Goldstone Works).

The depth of the shafts varies of course as the level of their sites. At Goldstone Bottom there are four, and their depth is 150 feet and more. The tunnels vary somewhat in size, up to a height of 18 feet and a width of 12 feet. Under ordinary circumstances these tunnels are filled with water; but, in order to extend them, they were practically pumped dry (except for small channels by the side), and about 2,000,000 gallons of water were run to waste daily, after enough had been taken for the supply of the town and neighbourhood. By the skilful management of the resident engineer, Mr. Baker, the chalky water, that comes from the parts where work was going on, was kept separate from the ordinarily clear water of the springs cut; so that the supply was still got whilst the work went on.

The tunnels are in white chalk, with but few flints in the flat planes of bedding; but with many oblique layers of thin flint filling joint-planes. These, it should be remarked, are evidence of water-flow, having probably been formed by slow deposit from water along the joints. Some joint-fissures on the other hand are filled with a soft calcareous and sandy deposit, the sand brought down from above by the sinking water. Though some of the chalk seemed fairly soft, yet I am told by Mr. Easton, that much of it was found to be very hard, needing, almost constantly, chisels and sledge-hammers to break it, picks being often of no use.

At Goldstone Bottom the length of the tunnel was 1800 feet in 1881, to which there had since been added (or would be added by the work in progress) 2600 feet.

The supply comes chiefly from three or four springs yielding from 4000 to 5000 gallons a minute, a long way apart. Though there are many small additions between these, yet it is noteworthy how far, in these works, a tunnel has been driven before cutting a fissure yielding a large supply, as this points to the need, in some cases, of great lateral extension to get the required supply from the Chalk.

Had recourse been made to boring, or even to a shaft, only, failure would almost certainly have ensued, where now the most successful result has followed from driving galleries. At the Lewes Road Works a different state of things occurs: the springs are very much smaller and nearer together, in the 2400 feet of tunnel.

It has occurred to me that the concentration of the underground water at Goldstone Bottom may perhaps tend to explain the occurrence of the basin there, the water having a freer course there than elsewhere, and therefore escaping more readily to the sea, and carrying away more chalk in solution.

At the time of my visit the tunnels were brilliantly lit up, by means of candles fastened to the sides, so that we could see the length of the tunnels (in one case about 800 feet) and all the springs issuing from the bottom. The large springs were seen to be in connection with joint-planes, which, though for the most part closed, or nearly so, yet, I was assured (by Mr. Baker, who accompanied me), were open where the water came out, so that a man's arm could be thrust in the opening.

Some small inflows of water from the upper part of a tunnel seemed to communicate nearly directly with the ground above, as, though running, or rather gently trickling, at the time (after some wet weather), they had not been seen before, in the dry weather. It was strange indeed to see the great extent of side that was quite dry, damp being the exception, and to think that, were pumping stopped, the whole would be filled with water in 6 or 8 hours.

In the North-eastern tunnel the roof is throughout of one bed, rarely needing support. At the bottom of this bed of chalk there was a thin, but continuous, layer of flint, which, being brittle, had been cleared away. It is curious that the end of this tunnel has struck on an old well, probably one that was made in the early part of the century, when a number of French prisoners of war were encamped on the site of the works.

Some weak places in the tunnels had been strengthened by brickwork; but for the most part the chalk is firm enough to stand.

To conclude, the visit to these important works, so liberally opened for us by the Corporation of Brighton, could not fail to be of the greatest interest to those present, and to be a source of instruction to all interested in the important question of water-supply from the Chalk.

V.—Inquiry concerning the Distribution of Teredo-bored Wood in the Eocene.

By J. Starkie Gardner, F.G.S.

THE habits and distribution of this marine molluscan pest chiefly concern the engineer and ship-builder at the present day, but in the past their presence is a considerable guide to the geologist as to the conditions under which many of the Eocene beds were deposited. It does not seem to have existed in the Gault sea, for though the drift-wood of this period is riddled by some of its destructive ancestors, such as *Teredina*, Lamarck, and perhaps *Xylophaga*, it is far less completely

destroyed than when the true ship-worm has been at work.[1] Something very like it is present in the Chalk; but when we come to the Eocenes, there is no longer any possibility of doubt as to the animal which has made its home in the drifting logs, for they are riddled in the way peculiar to the true ship-worm, and its shell is frequently left in the bore-holes. The distribution of such bored wood in our Eocenes must prove very instructive in many ways, when the habits of the living animal are more thoroughly known. As far as my own observations go, it occurs in the following beds, but I trust many of our numerous local observers will contribute additional and more precise information.

Thanet Beds.—A good deal of the silicified wood from the Thanet series of Herne Bay is bored by Teredo. Mr. Dowker, F.G.S., observes that most of the perforations are parallel with the grain of the wood, and mostly range from $\frac{3}{10}$ to $\frac{5}{10}$ of an inch in diameter, though there are many smaller bores associated with them.

Reading Beds.—I have no recollection of meeting with Teredo-bored wood in this formation.

Woolwich Beds.—Teredo has been recorded from Charlton and Sunderidge. It is probable that all wood from these deposits will prove to be bored by the ship-worm.

Oldhaven Beds.—Teredo is recorded by Mr. Whitaker from Charlton, Sunderidge, and Reculvers.

London Clay.—In reply to my inquiry, Mr. W. H. Shrubsole, F.G.S., has very kindly sent me a response which I cannot do better than quote:—

"Of the very large number of fossil trunks that I have observed, in nearly every case, if not in all, it has been evident that the Teredo borings were on one side of the ovally compressed stem, and in every instance where I have examined these trunks *in situ*, either in the cliff or on the undisturbed clay floor of the foreshore, I have found the borings only on the underside. This seems to show that the Teredo attacked the log when it was floating at the surface, and that it was silted up very soon after becoming water-logged and going to the bottom.

"The upper surface generally has a limestone covering some inches in thickness. The trunks are nearly always cracked up into lengths varying from two to four feet. It is extremely rare to find a log, large or small, that has not been bored. I have just examined a segment of a large fossil trunk which I selected and brought home as being less mutilated by Teredo than any I had seen for a long time, and I find that its appearance quite supports the statement made above.

"Another segment of the same trunk I had cut up transversely into slabs. One of these slabs (polished) is at Jermyn Street, and another, I think, at Cromwell Road Museum. Reference to them will probably show that owing to destructive action on one side the natural axis is eccentric.

[1] *Teredo* has been recorded from the Jurassics, but the generic identity is, I think, doubtful.

"I have found living Teredo in wreckage and other timber that had been drifting about for some time in the same relative position as in the fossil trunks. W. H. S."

Some of the logs at Sheppey must have been entire trunks of large trees, and they seem to have become water-logged and sunk before the Teredo had penetrated through even to the core, but in the vicinity of London, where wood in a calcified state is found in smaller pieces, it is invariably completely riddled. I only recollect observing it elsewhere at Harwich and Herne Bay, but there is no doubt that most of the wood, except small twigs, is universally bored by Teredo in this formation.

Lower Bagshot Formation.—I cannot trace the occurrence of any bored wood in these beds at Corfe, Studland, Alum Bay, or elsewhere in Dorset and the adjoining borders of Hampshire, neither does Mr. Keeping recollect any at Whitecliff Bay. I have found it, however, in company with Mr. Hudleston, in the cutting near Walton.

Middle Bagshot Formation.—The wood throughout this great formation is invariably completely riddled, except in the lowest beds overlying the Lower Bagshot in the neighbourhood of Poole Harbour and inland to the N.W. of Bournemouth. There is frequently so little of the substance of the wood left that it appears as a mere dark stain in the sand separating the casts of the tubes. The logs in the Bournemouth beds are never large, seldom exceeding three or four feet, and are riddled quite through and through. In a higher part of the series, at Hengistbury, the logs are larger, sometimes five feet long and two or more feet in width, and the bores are relatively gigantic, being upwards of an inch in diameter, sparsely scattered, and obviously the work of a different animal. Wood from the true Bracklesham beds, wherever met with, is invariably bored by Teredo.

Upper Bagshot Formation.—Wood is always more or less bored in these beds, though less extensively so perhaps in the Barton series than in the Bracklesham beds just noticed, for solid pieces occur in the former, but not in the latter. I am indebted to Mr. Keeping for corroborating this observation, and extending it to the same series in Whitecliff Bay, where I had not noticed any wood.

Lower Headon Beds.—Neither Mr. Keeping nor myself have noticed bored wood, at Hordle and in the Isle of Wight, in this formation.

Middle Headon Beds.—Mr. Keeping tells me that wood is invariably bored in the Brockenhurst beds, but I have no notes regarding wood in the beds at Colwell and Totland Bays.

Upper Headon Beds.—No bored wood occurs in these.

Bembridge Series.—Mr. Keeping and myself are confident that no Teredo-bored wood occurs in any part of this series, unless in the brackish series near Whitecliff Bay, where none however has yet been observed. Mr. E. A'Court Smith writes, "I have never noticed Teredo-boring in any of the wood here, though some of the wood is apparently perforated by a species of beetle (or White-Ant?). So great is the perforation in some cases that the wood drops to

fragments on being released from the matrix." I find no record of Teredo from the Hempstead beds.

I have never met with any Teredo-bored wood in the Antrim and other northern Eocenes, nor at Bovey Tracey. Additional information would be of importance, especially with regard to the London Basin, where the tubes often remain as hard cores of pyrites, when the wood itself is soft and perishing. They are rounded and blunt and closed at the thick end and open at the thinner end, and in this state are often mistaken for plant-remains such as roots or stems. On one occasion I was sent for to Bournemouth on account of the supposed discovery of fossil canes or reeds *in situ*, these being nothing more than casts of Teredo-boring in a vertical position.

With regard to the habits of the living Teredo, it was, I believe, for a long time assumed to be a purely marine mollusc, and its occurrence in Eocene deposits that were quite obviously of fresh-water origin was a serious stumbling-block. It has gradually been ascertained, however, to ascend very far up tidal rivers; but whether it ever passes up completely beyond the influence of saline water, is a question that appears to be unsettled. It is one, however, which must be set at rest, if we are ever to understand, and be in a position to restore, the physiography of the great river to which the deposition of the entire English Eocene basin is due.

The late Dr. Gwyn-Jeffreys appears to have collected more information bearing on this point than any previous writer, and the following is an extract from his British Conchology, p. 147:—

"*T. Senegalensis*, de Blainv., was discovered by Adanson in the roots of the Mangrove and another kind of tree lining the banks of the Niger, Gambier, and other rivers on the W. coast of Africa, which were only subject to an influx of sea-water for a few months in the year. According to Adanson, the water of these rivers is quite fresh or sweet during the remaining months; and *T. Senegalensis* not only exists, but retains its full vigour throughout the whole year. This statement, however, must be received with some qualification. I was assured by Dr. Welwitsch, the great botanical traveller, that in the tidal rivers of South Africa, the water in the middle stream is fresh, while that of the sides is brackish, and that no kind of Mangrove has been known to live in fresh water. Another sort of ship-worm (*Nausitora Dunlopei* of Perceval Wright) has lately been found in India, inhabiting the river Comer, one of the branches of the Ganges, and a perfectly freshwater stream, that joins the main river at a distance of about 70 miles from the sea. Dr. Kirk, the friend and companion of Livingstone, informs me that he picked up a piece of ebony (*Dalbergia melanoxylon*) on a sandbank in the Zambesi river, the water of which was there always fresh and drinkable 100 miles from the sea—very far beyond the influence of the tide, which never comes more than 10 miles up the creeks of the delta. This piece of ebony was pierced in all directions by a species of *Teredo* having a calcareous sheath. The kind of wood mentioned by Dr. Kirk resembles the ebony of commerce, but is utterly worthless except as fire-wood; and therefore it is not

at all likely that the piece in question could have been accidentally brought inland, after being perforated in the sea by *Teredo*. It sinks in water, is rather brittle, much harder and far more compact than either mahogany or teak, and is full of some mineral matter that quickly deadens the edge of any tool. It does not grow on the coast, nor within 50 miles of it on the Zambesi. Dr. Kirk adds that in the bottom planks of the pinnace belonging to the expedition, the ship-worm was also found, with its soft parts attached to the finely sculptured valves. The boat was so riddled that the quartermaster pushed a paint brush through her double planks. This was at Tete, 250 miles from the sea, after the pinnace had remained there six months at anchor. I regret not having space to give *in extenso* Dr. Kirk's interesting account of all the circumstances connected with this discovery. There is not the slightest doubt that the Teredo *observed by him inhabits water which is at all times perfectly sweet and fresh.*"

With regard to its occurrence in fresh water in India, a letter from a member of the Survey appeared in "Nature" of April 19th, 1877: "That the delta of the Irawadi, a tangled maze of creeks, the waters of which are brackish or salt for about half the year, and slightly so, and even potable during the other months. The large canoes which traverse these creeks are much infested by ship-worm, and are fired to get rid of them. I cannot recall any instances of bored wood well above the tide-way, but wherever the water is occasionally brackish, thus far the worms seem capable of settling. Perceval Wright has described *Nausitoria Dunlopei* from the rivers of Eastern Bengal as *Novaculina gangetica*. The two Burmese species of *Scaphula* are both estuary forms, whereas the type of the genus in the Ganges is found a thousand miles from the sea."

Dr. W. T. Blanford, F.R.S., in reply to my question, almost disposes of the contention that *Teredo* actually becomes a *bona-fide* freshwater mollusc, so far as India is concerned. He writes: "I know nothing of any occurrence of *Teredo* in Indian freshwater, and as I for many years paid a good deal of attention to Indian freshwater shells, I should be much surprised if *Teredo* were really found in fresh water there. The genus, however, abounds in the salt and brackish water of estuaries; all dead wood and even dead branches of living trees being riddled with borings of several different forms. I have seen them abundantly in the deltas of the Ganges and Irawadi rivers. The estuarine molluscan fauna is very rich and peculiar in India. At times of flood the quantity of water pouring down the rivers is so great that estuaries become temporarily fresh, and in this case estuarine forms may be found living in what is for the time freshwater."

There is still, however, considerable doubt as to the limits to which the ship-worm penetrates in Australian rivers, and naturalists with whom I have conversed seemed under the impression that it might be met with above rapids, and altogether out of reach of even an occasional mixture of brackish water. The only further information I have, is contained in a letter to "Nature," May 3rd, 1877,

in which Mr. Arthur Nicols, speaking from recollection, says that "*Teredo navalis* is certainly able to endure a long continuance of freshwater. At Brisbane the river is subject to freshes, one of which lasted ten days, when the flood was so powerful that ocean steamers could not get up. Salt-water is said at floods to ascend thirty miles beyond the town, which is itself twenty-five miles from the Pacific,—but the ebbs are more fresh than salt. Piles have to be protected with Muntz metal."

It will be seen that more definite information is required on all the points raised. There is said to be a freshwater *Carcharias* in the rivers of Fiji, and it would be interesting to learn whether it also ever lives wholly beyond the tidal reaches, or merely ascends rivers, as seals will, in search of food.

It thus appears, so far as we can go at present, that Teredo chiefly flourished during our Eocene time in waters that were clearly estuarine. The purely salt water reaches of the great river, such as those in which the London Clay and Bracklesham beds were deposited, were less favourable to its development than the almost fresh-water reaches in which the Bournemouth fresh-water beds and the Lower Bagshot of the London Basin were formed. In this last class of deposits there is no other sign whatever of aquatic life, either fresh or salt, and we are forced to conjecture that perhaps frequent change from quite fresh to quite salt water was the excluding cause. In what were perhaps more littoral marine beds, out of the influence of the river, such as those of Herne Bay and Highcliff, the Teredo seemed comparatively to languish, and it is quite excluded from the higher reaches of the river in which the Lower Bagshots of Studland and Corfe were formed, and which from the presence of *Unio* would appear to have been wholly freshwater. It had no place in the lacustrine deposits of Headon and Bembridge, and even the brackish and salt waters of these formations seem to have been quite unfavourable to it, being, it appears, from their teeming life, too permanently either fresh or salt. Without its presence we might never have suspected that many important masses of sediment containing terrestrial vegetation had ever been formed within the influence of the tides of the sea. Sufficient has been said to illustrate the peculiar local significance that the record of this destructive mollusc may possess with regard to the origin of a formation. It is noteworthy that the Eocenes possess three distinct types of *Teredo* which have not as yet been distinguished.

NOTICES OF MEMOIRS.

I.—Report on the Geology of the Kimberley District, Western Australia. By Edward T. Hardman, etc., of H. M. Geological Survey of Ireland. Fcap. pp. 22, 16 Plates, Map. (Perth, W.A., 1884.)

THE country described in this very excellent report comprises that portion of Western Australia extending from Roebuck Bay

inland to the Leopold Ranges, and between Port Usborne, and a line running eastward to the south of the Fitzroy River (lat. 16° 35′ and 18° 30′ S., long. 122° 10′ and 126° 50′ E.), including in all 12,800 square miles.

It may be generally described as a vast undulating plain, rising gradually from the sea-coast to a height of 200 ft., broken by isolated hills and some extensive mountain ranges, the highest reaching 2000 ft. above the sea-level. The district is unusually well watered, The geological formations represented over this immense tract of country consist of Recent accumulations, Pliocene sand and gravels, Carboniferous sandstones, grits, and limestone, and Metamorphic rocks.

The Recent accumulations are—(*a.*) Wide sand-flats locally termed "Marshes," along the sea-coast, and extending inland for miles, the most striking instance being the great plain from Roebuck Bay to Barlee Spring. The contained fossils are of recent species. (*b.*) Alluvium deposited by successive floodings of the rivers, estimated as equal to 3355 square miles, or 2,147,200 acres. But taking into consideration an average thickness of 30 ft., we have the "enormous weight of 103,924,480,000 tons of silt and mud carried down by these rivers" of the Kimberley District. (*c.*) River-gravels accumulated in the upper reaches of many of the streams (notably in the Usborne district), the pebbles often reaching six to nine inches in diameter. These subdivisions comprise the "Recent" formations described by Mr. Hardman.

Certain deposits of reddish sand, with small pea-like nodules of ironstone, and other rocks, with beds of red and yellow-ochreous earth, are provisionally classed as Pliocene. They are termed the "Pindan" sands and gravels, and occupy a very large area, and have been proved to be at least 30ft. in thickness. They are unfossiliferous, "but there can be little question that they are of comparatively recent age."

The Carboniferous rocks appear to be separable into an upper and lower series. The upper consists of sandstones, and forms the chief mountain ranges, extending as much as 190 miles into the interior, and are over 1000 ft. in thickness. *Lepidodendron*, *Calamites*, and *Sigillaria* are said to occur in these beds, but no traces of coal have been met with. The apparently overlying Carboniferous Limestone extends in a line N.W. and S.E. directly across the Kimberley district, with a maximum breadth of thirty miles, and an estimated thickness of 1000 ft. "It is a light-coloured, compact, brittle, splintery, more or less Magnesian Limestone," and bears a strong resemblance to the Upper Carboniferous Limestone of Ireland. It is in places very cavernous. Fossils were met with abundantly at certain localities, and the list of species given by Mr. Hardman clearly bears out the age assigned to the beds.

The Metamorphic rocks are divided into two classes—the schistose, including gneiss schist and metamorphic granite, and quartzites and altered grits. The former are widely developed along the base of the Leopold Range, and contain quartz veins, and the common garnet

in great abundance. The quartzites and altered grits constitute the mountainous country in Kimberley, and are interstratified with red and yellow sandstones, conglomerates, and grits.

Dykes of felstone, of later age than the Metamorphic rocks, are also met with. No precious metals were discovered, but Mr. Hardman believes in their discovery being probable in this series.

The Report is accompanied by sixteen geological views, and a very good map.

II.—The Lias of Fenny Compton, Warwickshire.

MR. THOMAS BEESLEY, F.C.S., has just issued this paper with additions and corrections to the end of 1885. The author describes the situation of Fenny Compton as a little station on the Great Western and East and West Junction Railways, on the Warwickshire side of the boundary between that county and those of Oxford and Northampton, eight miles from Banbury and twelve from Leamington, and at an elevation of nearly 400 feet above the sea. He points to the Burton Hills, whose bold escarpment forms so pleasing a feature in the landscape, as the extremity of the Marlstone promontory which stretches from the Cherwell valley into the Lower Lias bay of Warwickshire. He then directs attention to the sources of the Leam, the Cherwell, and the Nene, flowing respectively to the Severn, Thames, and Ouse, which sources are all within a circle of one mile radius, in the high ground above the Marlstone escarpment of Northamptonshire, a short distance east of the Burton Hills. The railway at Fenny Compton passes for nearly three-quarters of a mile through a cutting which exposes a section of the lowest zone of the Middle Lias, which, with the exception of those on the Dorsetshire and Yorkshire coasts, is probably the most extensive to be met with in England. The zone of *Ammonites Jamesoni* which occurs at Fenny Compton is, with the two others next above it, referred to the Lower Lias in the maps and memoirs of the Geological Survey of England; but, under the circumstances, the author prefers the continental arrangement. Proceeding southwards upon the East and West Junction line, the banks rise rapidly, exposing a bluish-black shale, fine in texture and rather marly. With one doubtful exception, none of the Ammonites of the Lower Lias have been found there. Some geologists have attributed this bed, and a good deal above it, to the "Raricostatus zone" of the Lower Lias, but Professor Tate, who had carefully examined it, agreed with the author that there was an error in the conclusion.

The bed soon presents unmistakable Middle Lias characteristics in the form of parallel lines of pale grey or reddish flattened nodules. They are much more calcareous than the clay in which they are embedded, and contain a notable amount of phosphoric acid, chiefly combined with lime. There are five lines of conspicuous nodules in the 40 feet of shale. The lower nodules, like the shale in which they lie, are rather poor in fossils, though both become richer in higher ground. The author possesses a small one containing on its surface 50 specimens belonging to more than 20 species, one of which

is a *Discina*. About a quarter of a mile from the station, two noticeable bands of stone occur about 40 feet above the base of the section. The upper stone is separated from the lower by 4 ft. 6 in. of dark blue clay with many fossils. It is of the same mineral character and appearance as the lower; but contains corals of the genus *Montlivaltia*, while corals are no longer present in the lower. The *Spiriferinæ*, which play so important a part in the fauna of the upper stone band, as well as the corals and *Waldheimia numismalis*, are absent from the Yorkshire Lias. The dip of the beds is distinctly to the south, as the stone bands sink below the surface, at a distance of about a third of a mile beyond the spot where they first appear. The true dip is about three-fourths of a degree. Above the stone bands, the shale gradually becomes greyer, rougher, and more lumpy, many of the lumps containing impressions of fucoids.

The following is a detailed section of the Fenny Compton beds:—

	Ft.	in.
Rough shaly clay	20	0
Band of calcareo-argillaceous nodules		2
Shale	10	0
Band of nodules with *Am. Henleyi, A. Ibex, A. Maugenetii, A. Valdani*		3
Shale	8	0
Band of nodules with *Am. Maugenetii*, and Fucoids		2
Shale, with Belemnites	2	0
Rough, shelly, argillaceous limestone, with *Am. Valdani*, and *A. Jamesoni*, *Spiriferina verrucosa*, *Belemnites clavatus*, *Lima Hettangiensis*, *Waldheimia numismalis*, *Rhynchonella rimosa*	1	0
Shale, with Belemnites	4	6
Rough, shelly, argillaceous limestones with *Am. armatus* (*young*). *Pecten priscus*, *Limea acuticosta*. *Gryphæa obliquata*, *Cardinia attenuata*, *Rhynchonella rimosa*. Corals		9
Shale	1	8
Band of nodules		3
Shale	3	0
Band of nodules with *Pecten calvus*, *Terebratula subovoides*		3
Shale	14	0
Band of nodules		2
Shale	5	0
Band of nodules		2
Shale	3	6
Band of nodules		2
Shale	22	0
	97	0

III.—Annalen des k. k. Naturhistorischen Hofmuseums; redigirt von Dr. Franz Ritter von Hauer. Band I. No. 1. Jahresbericht für 1885, von Dr. F. von Hauer. (Wien: 1886.)

Annals of the Royal Natural History Museum. Edited by Dr. F. von Hauer. Vol. I. No. 1. Annual Report for 1885, by Dr. F. von Hauer. (Vienna: 1886.)

THIS report contains a review of the progress made in the organization of the New Natural History Museum of Vienna under the superintendence of the well-known mineralogist, Dr. von Hauer, the successor of the late Dr. F. von Hochstetter. Until lately, the

various Natural History collections of the Austrian capital were deposited in different buildings, under independent management, but they have now been brought together in a magnificent edifice expressly constructed to receive them. The Museum includes the following five divisions: (1) Zoological; (2) Botanical; (3) Mineralogical and Petrographical; (4) Geological and Palæontological; (5) Anthropological and Ethnographical. Dr. A. Brezina and Theodor Fuchs are the keepers of the third and fourth departments respectively. The mineralogical collection is noted more particularly for its meteorites, of which there are 1207 specimens from 365 different localities; and the special forte of the palæontological division is the splendid collection of Tertiary mollusca.

A special library is being formed in connection with the museum, and we notice with pleasure the facilities provided for carrying forward original research whether by the museum officials or by voluntary independent investigators.

The present number is intended as the first of a series in which it is proposed to publish, together with the museum report, original memoirs on various natural history subjects.

IV.—Die Crinoïden des norddeutschen Ober-Devons. Von A. von Kœnen, in Göttingen. Neues Jahrbuch für Mineralogie, etc., 1886, Bd. I. p. 99–116, Plates I.—II.

OWING to their defective state of preservation, very little has hitherto been known of the Crinoids of the Upper Devonian strata of North Germany. Prof. von Kœnen in this paper gives the results of a critical examination of specimens which he has for many years been collecting, as well as of those preserved in the Museums of Bonn, Berlin, and Aix-la-Chapelle. From a comparison with the forms from the Famennien group of Senzeille in Belgium, described by Fraipont, the author has been able to determine the position of the anal plate and the composition of the ventral roof of the calyx of the different species; characters, which the author regards as of special value in the determination of species. The following species are described and figured:—*Melocrinus gibbosus*, Goldf., *M. hieroglyphicus*, Goldf., *M. Chapuisi*, Dewalque, *M. Dewalquei*, n. sp., *M. Benedini*, Dew.-Fraipont, *Hexacrinus infundibulum*, n. sp., *H. angulosus*, n. sp., *H. verrucosus*, Dewalque, *H. tuberculatus*, n. sp., and *Storthingocrinus sphæricus*, sp. n. G. J. H.

V.—Records of the Geological Survey of India, Vol. XIX. Part 1, 1886.

THIS part contains, with other papers, the Annual Report of the Geological Survey of India by Mr. H. B. Medlicott, in which attention is more particularly called to the discovery, by Dr. Warth, of Palæozoic fossils in the Salt Range of the Punjab, in strata, associated with a noted Boulder-bed, which have hitherto been regarded as belonging to the Cretaceous series. The fossils, which have been determined by Dr. Waagen, include several species of *Conularia*, *Bucania*, *Nucula*, *Atomodesma*, *Aviculopecten*, *Discina* and *Serpulites*,

some of which occur in Carboniferous strata in Australia, and others are related to species from the Carboniferous Limestone of Belgium. A further interest attaches to this discovery of Carboniferous fossils in connection with the Boulder-bed in the Salt Range, from the probability that this bed may be identical with the Talchir boulder glacial deposits found almost everywhere at the base of the Gondwana rocks of Peninsular India. These in turn have been correlated with remarkable Boulder-beds, believed to be due to ice-action, occurring in the Carboniferous series of Australia. Mr. R. D. Oldham has lately visited Australia, and contributes, in this part, a highly important memorandum on the subject. This further evidence strongly supports the original views of Dr. Blanford as to the Palæozoic age of the Lower Gondwana deposits, and, as Mr. Medlicott remarks, "it would be the first clear and broad case to confirm the assertion, made twenty-five years ago by Prof. Huxley, when introducing the term 'homotaxis,' for it shows that a full-blown Mesozoic flora in one region of the earth was contemporaneous with a full-blown Palæozoic flora in another region."

Under "Afghan and Persian Field Notes," Mr. C. L. Griesbach, who accompanied the Afghan Boundary Commission as geologist, gives an outline sketch of the various geological formations, which range from the Post-Tertiary to the older Palæozoics, occurring in the Herat Valley and Khorassan.

The other papers in this part are "Notes on the Section from Simla to Wangtu," by Col. McMahon, and an excellent "Report on the International Geological Congress of Berlin," by Dr. W. T. Blanford, F.R.S. G. J. H.

VI.—Contributions à la Géologie des Pays-Bas. Par Dr. J. Lorié. Résultats Géologiques et Paléontologiques des Forages de Puits à Utrecht, Goes et Gorkum. Extrait des Archives Teyler, Series II. tom. ii. Large 8vo. pp. 132, and 5 lithographic plates. (Haarlem, 1885.)

THE opportunities of studying the structure of the earth's crust in a flat country like the Netherlands are indeed few and far between. There are no coast or valley sections, and owing to the general level character of the country, scarcely any artificial cuttings are required for the railways. Under such circumstances, well-sinkings afford the best, and almost the only means of ascertaining the stratigraphical succession. In the course of the last few years, three important sinkings have been made in this country, at Utrecht, at Goes on the island of South Beveland, and at Gorkum in South Holland. The first of these was carried to the depth of 369 mètres, that at Goes to 223·9 m., and that at Gorkum to 182 m. beneath the surface, which, in each case, did not exceed 5 m. above the sea-level. The distribution and the characters of the fossils met with in these well-borings have been carefully investigated by Dr. Lorié, and this memoir contains critical descriptions and figures of the different species and tabular lists of their occurrence in the beds at different

depths, and a comparison with those in strata of corresponding age in Belgium and East-Anglia.

The strata pierced in these well-borings consist entirely of beds of gravel, sand and clay, of Tertiary and Quaternary age, some barren of fossils, others with shells, bryozoa and other fossils. There are 131 species enumerated, all of which have been previously described. In the Goes boring the entire thickness of the Pliocene is penetrated. The Lower Pliocene or Diestien, the equivalent of the Coralline Crag, has a thickness of 37 mètres. It contains a certain proportion of Polyzoa and appears to have been deposited in a tolerably deep sea. It rests upon the Rupélien clay of Middle Oligocene age. The Upper Pliocene or Scaldisien, the equivalent of the Red Crag of East-Anglia, has a thickness at Goes of between 23 and 29 mètres. Above this comes the so-called Diluvial beds, about 47 mètres in thickness. At Utrecht the Diestien beds have a minimum thickness of 125 m. and their base is not reached. They are principally greyish-green sands with intervening bands of clay, and the absence of Polyzoa and the broken condition of the shells indicate a shallower sea than at Goes. The Scaldisien or Red Crag has a thickness of 82 m., and there are above it beds of Quaternary and Recent age 162 m. in thickness. At Gorkum the base of the Scaldisien or Red Crag was not reached at the depth of 182 m. This deposit has thus a minimum thickness of 62 m., and from the fragmentary and triturated shells therein, it appears to be of littoral origin. Above this are freshwater beds, 28 m. in thickness, of Quaternary age. With the exception of the first 12 m. of recent deposits, the intervening strata 80 m. in thickness are also of Quaternary age.

This memoir is a valuable contribution to the history of the later fossiliferous strata in a new area, and it has a special interest to the student of the corresponding beds in East-Anglia. G. J. H.

REVIEWS.

I.—Bulletins of the United States Geological Survey. Nos. 1–19. (Government Printing Office, Washington, 1884–5.)

IN addition to the large volumes of the Annual Reports, and the magnificent Monographs, the United States Geological Survey are also issuing a series of Bulletins, each on a special subject and complete by itself. Nineteen of these papers have already been published. Some of them, it is true, treat of subjects which are but remotely connected with geological research, as, for instance, "Gold and Silver Conversion Tables," giving the coining value of Troy ounces of fine metal, etc., and "Boundaries of the United States and of the several States and Territories;" others, though not directly geological, are of great practical value to all geologists working in the United States and Canada, as, for example, "A Dictionary of Altitudes in the United States" and "Elevations in the Dominion of

Canada;" whilst others are of interest to geologists generally. We regret that space does not permit us to mention more than the titles of the Bulletins of this latter description; it may suffice to state that their respective authors are all well-recognized authorities on the subjects of which they write. The following are on palæontological matters:—"On Mesozoic Fossils," by Dr. C. A. White, who also contributes papers "On the Mesozoic and Cenozoic Palæontology of California," and "On Marine Eocene, Freshwater Miocene, and other Fossil Mollusca of Western North America." "On the Fossil Faunas of the Upper Devonian along the Meridian of 76° 30′," by Prof. H. S. Williams. "On the Cambrian Faunas of North America," by C. D. Walcott. "On the Quaternary and Recent Mollusca of the Great Basin," by R. E. Call; and "On the higher Devonian Faunas of Ontario County, New York," by J. M. Clarke.

The following treat of petrological and mineralogical subjects:—"On Hypersthene-Andesite and on Triclinic Pyroxene in Augitic Rocks," by Whitman Cross, with a geological sketch of Buffalo Peaks, Colorado, by S. F. Emmons; "On Secondary Enlargements of Mineral Fragments in certain Rocks," by R. D. Irving and C. R. Vanhise; "A Crystallographic Study of the Thinolite of Lake Lahontan," by E. S. Dana; and "On the Development of Crystallization, etc.," by Arnold Hague and J. P. Iddings.

Besides the above, Mr. George F. Becker contributes "Notes on the Stratigraphy of California," and MM. Jules Marcou and J. B. Marcou, "A Catalogue of Geological Maps of America (North and South) 1752–1881."

These Bulletins, in all cases where the subject-matter requires illustration, are furnished with well-executed plates, in one instance these are beautifully coloured. Further, these papers will not be less appreciated on account of the fact that they are published at such moderate prices as to bring them within the means of all geologists.

G. J. H.

II.—Memoirs of the Geological Survey of India. Palæontologia Indica. Ser. X. Indian Tertiary and Post-Tertiary Vertebrata, Vol. III. Parts 7 and 8. Siwalik Crocodilia, Lacertilia and Ophidia; and Tertiary Fishes. By Richard Lydekker, B.A., F.G.S., with ten plates, xxviii.–xxxvii. (London, Trübner & Co.)

WE noticed the previous issue of this important serial of Indian Palæontology in August last (see Geol. Mag. 1885, Dec. III. Vol. II. p. 371). The present part, which completes vol. iii., contains the Crocodilia, which occupy seven plates, some fragmentary remains of Lacertilia and Ophidia, Sharks, Siluroid fishes, etc.

The Crocodilia comprise only two species of true Crocodile, namely, *C. sivalensis*, Lyd., and *C. palæindicus*, Falc.; five species are referred to Geoffroy's genus *Gharialis*, namely, *G. gangeticus*, *G. hysudricus*, *G. curvirostris*, *G. leptodus*, *G. pachyrhynchus*, and a single species to a new genus, *Rhamphosuchus*, viz. *R. crassidens*. Some

of these old Gharials attained to enormous size, judging by the proportions of the parts preserved in the Falconer and Cautley Collection in the British Museum (Natural History), Cromwell Road, and in the Geological Survey Museum, Calcutta. Thus, "*G. pachyrhynchus*, from the Lower Siwaliks of Sind, was between two and a half and three times the size of full-grown existing specimens of *G. gangeticus*, which attains a total length of twenty feet. If the same proportions obtained in this fossil species, its total length would have been from fifty to sixty feet." (p. 21.)

A portion of a humerus of a *Varanus* indicates in a similar manner a lizard perhaps twice the size of the largest existing species (*V. salvator*), which, according to Mr. Theobald, attains a length of nearly seven feet; so that *V. sivalensis*, Falconer, may have been as much as from 12 to 14 feet long.

This Memoir also makes us acquainted with a series of ophidian vertebræ referred by the author to *Python*, and probably identical with the *Python molurus*, Linn. sp.

Many of the remains here described and figured were collected thirty years ago or more by the late Sir Proby T. Cautley, and a few have been described already by Dr. Hugh Falconer, F.R.S.

The fish-remains described embrace teeth of sharks, referred to *Carcharias*, sp.; and *Carcharodon*, sp., from the Siwaliks; palatal teeth of Rays, *Myliobatis*, from the Eocene of Kach; teeth of *Sparidæ* (*Capitodus*); *Ophiocephalidæ*, cranium of *Ophiocephalus*, and numerous cranial plates of *Siluridæ*, etc., very like, or identical with living Indian forms. This part also includes the Title-page, Index, and some Introductory Observations to complete Vol. III. of Series X. Some excellent figures of *Mastodon*-molars accompany and illustrate the Introductory Chapter, with which, when bound, the volume will commence.

This great work, carried out under the able administration of the Superintendent of the Geological Survey of India, Mr. Henry B. Medlicott, M.A., F.R.S., has of late years been wholly prepared by Mr. Lydekker, and printed, and illustrated, in England, and has thus had the best possible care and every advantage in its production; yet, nevertheless, it is sold at a *lower price* than any similar publication in Europe or America. We wish the publications of the Indian Survey the success they so richly and honourably deserve, and we compliment Mr. Lydekker, the author of the present volume, upon the completion of this section of his very excellent Indian Monograph.

It is interesting to mention, for the information of English Palæontologists, that a large number of the type-specimens figured in the volumes of the "Palæontologia Indica" are to be seen in the cases of the Geological Gallery of the British Museum (Natural History); so that this magnificent work is in a measure an illustrated and descriptive catalogue, not only of the Calcutta Museum, but in part also of our own Indian collections at home.

III.—Catalogue of the Fossil Mammalia in the British Museum (Natural History), Cromwell Road, S.W. Part II.[1] Containing the order Ungulata, sub-order Artiodactyla. By Richard Lydekker, B.A. 8vo. pp. i.–xxii. and 324l, illustrated by 39 Woodcuts. (London, 1885, printed by Order of the Trustees.)

WITH praiseworthy zeal Mr. Lydekker has finished another volume of the Catalogue of Fossil Mammalia in the Geological Department of our National Museum; indeed we are assured a third part is now actually passing through the press and will be issued this Spring.

The present section is a very large one (nearly 350 pages in extent), and is illustrated by thirty-nine woodcuts. It is confined entirely to one sub-order of the Ungulata, or hoofed-animals, the Artiodactyla, or even-toed Herbivora. In this sub-order are included the *Bovidæ*, *Giraffidæ*, *Cervidæ*, *Camelidæ*, *Tragulidæ*, the *Suidæ*, *Phacochœridæ*, and *Hippopotamidæ*, all of which families have *living representative species;* also the families *Dichodontidæ*, *Cœnotheriidæ*, *Anoplotheriidæ*, *Oreodontidæ*, *Merycopotamidæ*, *Anthracotheriidæ*, *Chœropotamidæ*, and *Listriodontidæ*, all the species of which are *extinct*. The following definition of the Artiodactyla may be acceptable.[2] In this sub-order the premolar and molar teeth are not alike, the former being single, and the latter two-lobed. The last lower molar of both the first and second dentition is almost invariably three-lobed. The nasal bones are not expanded posteriorly. They have no alisphenoid canal. The dorsal and lumbar vertebræ together are always nineteen, though the former may vary from twelve to fifteen. The femur is without a third trochanter. The third and fourth digits of both feet are almost equally developed and their ungual phalanges are flattened on their inner or contiguous surfaces, so that each is not symmetrical in itself; but when the two are placed together, they form a figure symmetrically disposed to a line drawn between them. In other words, the axis or median line of the whole foot is a line drawn between the third and fourth digits, while in the Perissodactyles (uneven-toed Ungulates) it is a line drawn down the centre of the third digit. The distal articular surface of the astragalus is divided into two nearly equal facets, one for the navicular and one for the cuboid bone. The calcaneum has an articular facet for the lower end of the fibula.

The Artiodactyla are naturally separable into two very well marked subdivisions, namely :—

A. The Selenodonta—including the numerous extinct genera and also the existing types of true Ruminants, and

B. The Bunodonta—containing the families of the *Hippopotamidæ* and the *Suidæ*.

Both these divisions are very well characterized by their dentition.

[1] Part I. of this Catalogue—containing the Orders Primates, Cheiroptera, Insectivora, Carnivora, and Rodentia—was noticed in the Geol. Mag. 1885, Decade III. Vol. II. p. 321.

[2] See Prof. Flower's Article "Mammalia," Encyclop. Britannica, 9th. edit. vol. xv.

The Selenodont (crescent-shaped) type of dentition is closely associated with the Ruminants and evidently has a direct relation with the cud-chewing habit of the Artiodactyle; whilst the Bunodont (or hill-toothed type) are well exemplified in the molar teeth of both the pig and river-horse, a pattern of tooth not met with out of this division save in certain Mastodons and in the teeth of *Halitherium*.

With regard to a large number of extinct forms, their true affinities are of course somewhat conjectural; nevertheless we may pretty safely infer that they were very near to, if not actually to be classed with the Ruminants proper (where the teeth are known). Mr. Lydekker commences his catalogue with the *Bovidæ*, under which section are included the Oxen, Bisons, Sheep, Goats, Antelopes and Giraffes. Following Boyd Dawkins and other authors, Mr. Lydekker sinks the great *Bos primigenius* into a mere gigantic ancestor of *Bos taurus*, and he does the same with the little *Bos longifrons*.

The other bovine species which remain are all foreign and Indian forms. The Bison retains its distinctness, and the Buffalo with its various Indian species. Then follows the Musk-sheep, which appears to have two extinct Pleistocene relatives in North America (probably only local varieties), about which little is known.

Succeeding these are the Sheep, Goats, Gazelles, Antelopes, completing the hollow-horned ruminants. Next after these are placed the Giraffidæ, with which are included the extinct genera *Sivatherium*, *Bramatherium*, *Helladotherium*; this last was formerly considered as the hornless female of *Sivatherium*, but it is now established as a distinct genus by Gaudry and Lartet, and also by Rütimeyer. Remains of the true Giraffe are also found fossil in India and elsewhere.

The solid-horned Deer-tribe follow next in order, with rugged branching antlers of *true bone* without a horny sheath, but covered during their growth with vascular integument coated with short hair. When their growth is finished, the supply of blood is cut off, the skin dies and peels off, leaving the bone bare and insensible, and after a time, by a process of absorption near the base, it becomes detached from the skull and is "shed," an event which occurs annually. After a time a new pair of horns are developed from the peduncles or base of the original pair. The collection affords examples of 38 species of *Cervidæ*—including the Roebuck, Elk, Reindeer, Gigantic Irish-deer, Fallow-deer, Red-deer, and a long series of extinct species, among which *Cervus tetraceros* from the Pliocene of France, and the *Cervus giganteus* from Ireland, are the most interesting and uncommon forms of simple straight-tined, and broadly palmate types.

The Camels offer no interest to the palæontologist, as they appear to have undergone scarcely any modification from existing species; but many of the ten extinct families which follow date back to the Eocene, such as the *Anoplotheriidæ*, the *Anthracotheriidæ*, the *Cœnotheriidæ*, etc.

If we except the *Anoplotherium*, the *Dorcatherium* and some few others, the greater number of these species are founded merely on teeth, jaws, etc., and but seldom upon associated skeleton remains;

from what we do know, however, concerning these earlier species, they are seen to be of the greatest interest, as offering forms intermediate in dentition, by which the ruminants and non-ruminants can in a measure be connected together, and also the Perissodactyla and Artiodactyla.

The *Suidæ* are a very remarkable group, being connected by the Chevrotains with the Deer-tribe (and possibly also with the Perissodactyla and Proboscidea, if not with the Sirenia also in past times).

The principal sources whence these early types of Mammalia have been obtained are from the Eocene freshwater beds of Hempstead in the Isle of Wight, the Headon beds, Hordwell, Hampshire; Vaucluse, Débruge, Montmartre, Caylux and many other localities in France; Hesse-Darmstadt in Germany, Pikermi in Greece, and the Siwalik Hills, India.

Some of the most ancient progenitors of the pig-tribe (*Elotherium*) also date back to the Eocene of Hempstead and the Lower Miocene of France. The *Hyotherium* is also regarded as an ancestral form of *Sus* or *Dicotyles*.

Sus giganteus and *Sus titan*, both from the Indian Siwaliks, were amongst the very largest ancestral forms of the Pig family.

The *Hippopotamidæ*, of which a short notice was given in the March Number of the Geological Magazine (p. 114), appear at a less early date than the pigs, but are of extreme interest. They are confined to the old world, over which they seem to have been very widely distributed in Pliocene and Quaternary times, but they are restricted now to the rivers and coasts of the African continent.

It is hardly possible to over-estimate the advantage derived by the publication of these Catalogues. They are an embodiment of all the (too-frequently) unwritten traditions concerning specimens in our grand National Collection, and Mr. William Davies has largely contributed, by his unostentatious, but earnest labours, to bring the remains of the fossil Mammalia in the Geological Collection into such a state as to enable them to be catalogued by Mr. Lydekker, a task too, in which, as stated in the preface, he has taken no small share. It is gratifying to be able to state that this portion of the geological galleries is in a highly satisfactory state, and reflects the greatest credit on the staff who have arranged it in so admirable a manner.

IV.—Catalogue of the Palæozoic Plants in the Department of Geology and Palæontology, British Museum (Natural History). By Robert Kidston, F.G.S. 8vo. pp. viii. and 288. (London, 1886, printed by Order of the Trustees.)

MR. ROBERT KIDSTON has been favourably known for some time past as a diligent worker in fossil Botany, and he has confined his attention mainly to the plant-remains of the Coal-formation.

Having named and catalogued the Coal-plants in the Museum of Science and Art, Edinburgh, and also contributed several papers to

scientific journals on palæobotanical subjects, he was entrusted in 1883 with the task of naming and cataloguing the Palæozoic plants in the Geological Department.

The present work, which was only completed at the end of 1885, is the result.

The plants catalogued are divided into Permian, Carboniferous, Devonian, and Silurian, of which the Carboniferous form by far the largest group.

The Permian contains		39	species.
,, Carboniferous contains		218	,,
,, Devonian	,,	38	,,
,, Silurian	,,	10	,,

The total number of recognized species represented in the Collection being 305.

It is probable that this number might be greatly increased, and that it does not represent more than a quarter of the total number of fossil plants described from the Palæozoic rocks of the whole world.

The method adopted by the author has been to give a *complete bibliography* of each species; this has entailed an enormous amount of labour, and largely serves to increase the bulk of the present catalogue. Should a new Edition be prepared, we would recommend the author to eliminate all but the important and essential references, and so thereby to greatly reduce the number of pages, whilst largely increasing the real usefulness of the work for purposes of reference.

Another feature of this work consists in the critical remarks, often extending to essays of from one to five pages in length, on questions bearing upon the structure or interpretation put by various authors on the fossil plant-remains recorded in the Catalogue.

Here is an example of one of Mr. Kidston's dissertations taken at random from the Catalogue:—

LEPIDOPHLOIOS, Sternberg, 1825.

Versuch eines geognostisch-botanischen Darstellung der Flora der Vorwelt, vol. i. fasc. iv. p. 13.

Lepidophloios laricinus, Sternberg.

Lepidophloios laricinus.
Boulay, Terr. Houil. du Nord de la France, p. 38.

[Here follow 41 references to works by various authors in which this genus is quoted. These we omit.]

(?) *Ulodendron tumidum.*
Carruthers, Monthly Micro. Journ. p. 154, pl. xliii. figs. 5, 6, 7, 1870.

Remarks.—It has been shown by Feistmantel, in his Steinkohlen-Flora von Kralup in Böhmen,[1] that *Halonia*, Lindley and Hutton, is only a fruiting branch of *Lepidophloios laricinus*, Sternberg, and later the same relationship of *Halonia* to *Lepidophloios* has been further explained by Dr. Macfarlane (Trans. Bot. Soc. Edinb. vol. xiv. p. 181, pls. vii. and viii.[2]). These figures alone, one would think, were sufficient to place the affinities of *Halonia* outside the circle of discussion, but notwithstanding the conclusive evidence they afford on this point, the view held by these writers has not been universally accepted.[3]

[1] Abhandl. der k. Böhm. Gesellschaft der Wissensch. vi. Folge, vol. v. 1871.

[2] Dr. Macfarlane's *Lepidophloios* is not *L. laricinus*, Sternberg, but a new species for which I propose the name of *Lepidophloios Scoticus*.

[3] See Renault, Cours d. Bot. Foss. p. 53, 1882.

Mr. Carruthers has also figured a specimen of *Halonia* attached to *Lepidophloios*,[1] which is in the Collection. The conclusion arrived at by him was very similar to that mentioned by Feistmantel, that *Halonia* was only a condition of *Lepidophloios*. Both on the Halonian-branch and the main stem of this example some of the characteristic leaf-scars of *Lepidophloios* are shown. Those on the *Halonia* portion are normal in form and point downwards, but on the main stem from some cause, perhaps pressure or distortion during or after mineralization, the leaf-scars are arranged at right angles to the direction they ordinarily hold on the stem; hence the two lateral angles of the leaf-scar lie parallel to the direction of growth, and the scar of the vascular bundle so twisted round, occupies one of the lateral angles.

In his last memoir on the "Organization of Fossil Plants of the Coal Measures," [2] Dr. Williamson gives a figure (pl. xxxiv.) of *Halonia* attached to a Lycopodiaceous stem. He says,[3] "In my second memoir (Phil. Trans. 1872, p. 222), read in June, 1871, I said, 'I have little doubt but that *Halonia* was a fruiting branch of a *Lepidodendron*;' and in a note added in April, 1872, I affirmed *absolutely*, 'First, that *Halonia* belongs to the upper branches of a Lepidodendroid tree, consequently it cannot be a root;' 'secondly, we learn that *Halonia* is a specialized branch of a Lepidodendroid tree that is not itself a *Halonia*.'" . . . "The specimen now described is unquestionably not a *Lomatophloios*, but a true *Lepidodendron*." In describing his specimen, he says further (p. 468), that at the lower portion of the branch the leaf-scars have exactly the same form as those of *L. selaginoides* and *L. elegans*, Lindley and Hutton. I have already mentioned that the leaf-scars on the specimen described by Mr. Carruthers are so turned round on the stem that instead of their greater diameter being transverse to the stem, as is normally the case in *Lepidophloios*, it is vertical. Dr. Williamson's figure does not show clearly the form of the scars further than that the vertical diameter of those on the lower part of the stem seems greater than their transverse breadth. The leaf-scars towards the upper portions of the specimen are rhomboidal. I am inclined to think there is here a case of distorted leaf-scars on the lower part of the fossil, similar to that occurring in Mr. Carruthers' specimen, where, notwithstanding this peculiarity, the fossil is clearly identifiable as *Lepidophloios laricinus*.

With such an imperfectly preserved example as Dr. Williamson's appears to be, any conclusion derived from it is of doubtful value, and though from an examination of his plate one cannot affirm his fossil is a *Lepidophloios*, equally one cannot say it is a *Lepidodendron*.

The figures given by Feistmantel and Dr. Macfarlane are conclusively affirmative that at least some *Halonia* specimens belong to *Lepidophloios*, whereas we have no example which shows in an undoubted manner that any *Halonia* fossil can be referred to *Lepidodendron*. My own opinion is that *Halonia* is exclusively related to *Lepidophloios* as its fruiting branch. Of course, those authors who place *Lepidophloios laricinus*, Sternberg, in *Lepidodendron*, may consistently say that *Halonia* is the fruiting branch of *Lepidodendron*, but I am not aware that any recent writer has followed this classification.

Lepidophloios and *Lepidodendron* I regard as essentially distinct genera. *Lomatophloios* is now united with *Lepidophloios*, hence I understand Dr. Williamson's statement that "The specimen now described is unquestionably not a *Lomatophloios*, but a true *Lepidodendron*," which is equivalent to saying that it is not a *Lepidophloios*, but a *Lepidodendron*.

Sigillaria Menardi, Goldenberg (Flora Saræp. Foss. pl. vii. fig. 1), appears to be referable to *L. laricinus*. The central point of the leaf-scars of this figure is probably the tubercle with which the leaf-supporting pedicels of this plant are frequently provided, as pointed out by Weiss. *U. tumidum*, Carr., the type of which is in the Collection, is, I think, also referable to *L. laricinus*. The leaf-scars are not well preserved on his type, but it probably finds its place here. It is not, at any rate, a *Ulodendron* as defined by Lindley and Hutton, for it shows more than two rows of the larger scars on the circumference of the stem, a third row appearing on the side not shown in Mr. Carruthers' figure.

Halonia tuberculata, Eichwald (Lethæa Rossica, vol. i. p. 148, pl. xi.), is another instructive example as illustrating the affinities of *Halonia*. The core out of this specimen is a typical *Halonia*, the impression *Lepidophloios*. In such examples as

[1] Geol. Mag. Vol. X. April, 1873. [2] Phil. Trans. 1883, clxxiv. p. 459. [3] l.c. p. 469.

these a layer of cortical tissue from between the core and the impression has evidently been removed by decay, after the cortical cylinder had been filled with sediment and the impression of the outer surface of the bark had been imparted to the surrounding matrix. An example in the Collection shows the same conditions—a removable *Halonia* core from a *Lepidophloios* impression.

The plant figured as *Knorria Sellonii*, by Lindley and Hutton (Fossil Flora, vol. ii. pl xcvii.), appears to be a compressed specimen of *Lepidophloios*. I have examined this type in the "Hutton Collection," of which their plate does not give a very correct idea.

I am unable to discover from what evidence Renault has restored his *Lepidophloios*, as represented in his Cours d. Botan. Foss. 1882, pl. xi. fig. 1. It appears to possess the large scars of one genus and the leaf-scars of another.

Horizon.—Coal Measures.

Localities.—*British.* Staffordshire: Ipstones.
Foreign. Bohemia: Radnitz. Silesia: Waldenburg.

Space precludes our giving a fuller notice of this Catalogue. An index and list of works quoted completes the book.

Mr. Kidston has visited numerous localities in search of species, and has added by his exertions nearly 250 specimens to the collection; it is hoped that other gaps which at present exist will ere long be filled by further donations.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—Annual General Meeting, February 19, 1886.—Prof. T. G. Bonney, D.Sc., F.R.S., President, in the Chair.

The Secretary read the Reports of the Council and of the Library and Museum Committee for the year 1885. In the former the Council stated that they had the pleasure of congratulating the Society upon an improvement in the state of its affairs, both from a financial point of view and on account of an increase in the number of Fellows. The number of Fellows elected during the year was 54, and the total accession amounted to 51; while the losses by death, resignation, etc., amounted to 46, making an increase of five in the number of Fellows. The number of contributing Fellows was increased by 15. The Balance-sheet showed an excess of Income over Expenditure during the year of £347 18*s.* 2*d.* The Council's Report further announced the awards of the various Medals and of the Proceeds of the Donation Funds in the gift of the Society.

In handing the Wollaston Gold Medal to Mr. Warington W. Smyth, F.R.S., for transmission to Prof. A. L. O. Des Cloizeaux, the President addressed him as follows:—

Mr. Warington Smyth,—In the absence, which we much regret, of Prof. Des Cloizeaux, I must request you to transmit to him this Medal.

Geology is the child of two parents,—Mineralogy and Biology. If we look to the latter to bid the dry bones and buried relics of organisms once more live, we appeal to the former to disclose the nature and constitution of the earth's framework whereon they flourished. It is therefore only just that our Society should seek opportunities of acknowledging the aid which we receive from mineralogists; and it would be difficult to find one on whom this Wollaston Medal could be more fitly conferred than on Prof. Des Cloizeaux. To enumerate the papers which he has written would be a formidable task; they numbered 141, so long as fourteen years ago; what, then,

must be the present total? I may, however, point, in passing, to his admirable "Manual de Minéralogie," and allude, as more directly bearing on the work of this Society, to his papers on the classification of hyperites and euphotides, on the geysers of Iceland, on the action of heat upon the position of the optic axes in a mineral, and the numerous memoirs on the distinction of minerals by their optical properties, especially those relating to microcline, and to other species of felspar, of the importance of which students of microscopic petrology are daily more sensible. I esteem it a great honour to be the means of carrying into effect the award of the Council by placing in your hands, to be transmitted to Prof. Des Cloizeaux, the Wollaston Medal, founded "to promote researches concerning the mineral structure of the earth."

Mr. Warington W. Smyth, in reply, said:—Mr. President,—It is, Sir, with more than ordinary satisfaction that I am privileged to receive for, and to transmit to, Prof. Des Cloizeaux the Medal founded by Dr. Wollaston. No one can fail to appreciate the appropriateness of this award when we consider the researches into the physical characters of minerals which have contributed so much to the petrological branch of our science, in which you, Sir, have taken so prominent a part. But it is more especially in the wide and successful application of Wollaston's invention of the Reflection Goniometer that Des Cloizeaux has attained so deserved an eminence, following closely upon the steps of Prof. Miller, to whom, in his admiral manual, he pays so high a compliment. The Society will regret to learn that Prof. Des Cloizeaux has been prevented by domestic anxieties from being present to-day.

The President then presented the Balance of the Proceeds of the Wollaston Donation Fund to Mr. J. Starkie Gardner, F.G.S., and addressed him as follows:—

Mr. Starkie Gardner,—The small number of students and the paucity of memoirs seems to indicate that fossil botany is one of those subjects of which the difficulties repel rather than fascinate the neophyte. If perhaps these are in some respects less formidable in the plant-remains of the earlier Tertiary period, if, in studying them, recent throws some light on fossil botany, yet the practical difficulties of obtaining, developing and preserving specimens are so great that no little ardour and patience are demanded from one who devotes himself to the subject. For years this has been your special work: after thoroughly exploring the flora of the Eocene Tertiaries on the coast of Hampshire and in the Isle of Wight, you are now, and have for some time been, engaged in communicating to us the fruits of your labours through the medium of the Palæontographical Society, thereby earning the thanks of students. Your researches also of late years have been extended to Antrim, Mull, and even Iceland, and their results cannot fail to be of the highest interest in regard to the age of these floras, and their relation to those which occur in the Hampshire district. In recognition of past and in aid of future work, the Council has awarded to you the balance of the Wollaston Fund, which I have much pleasure in handing to you.

Mr. Gardner, in reply, said:—Mr. President,—I beg to return my thanks for the honour the Council have done me in placing the balance of this fund at my disposal. The amount of leisure I am able to command has not permitted me to contribute towards the advancement of geology in this country in anything like the same proportion as my professional brethren; but I think I may fairly claim to yield to none in my devotion to its pursuit. The subject I somewhat unfortunately monopolize is one of such magnitude that, at the best, very many years of such work as I am able to devote to it must elapse before even a first general impression of the composition of our Eocene flora can be published. I am, however, so deeply impressed with the importance of the study that I am prepared to sacrifice much in order that the time required may not be unduly prolonged. I am convinced that in addition to the ordinary botanical, palæontological, and evolutionary interest attaching to it, it will be found to present the solution of many problems as to the former relative positions of land and sea and the climatic changes accompanying their successive redistribution. I need hardly add that I regard the award made me this day as a direct encouragement to persevere in the line of research I have chosen.

The President next presented the Murchison Medal to Mr. William Whitaker, B.A., F.G.S., and addressed him as follows:—

Mr. William Whitaker,—To many members of the Geological Survey of Great

Britain since the date of its constitution we are indebted for work freely done—beyond the sphere of their more strictly professional duties. Its chiefs, from the days of Sir H. De la Beche to the present distinguished Director-General, Dr. A. Geikie, have been among the most valued contributors to our Journal, and have enriched geological literature by their longer writings; while among its other members, few have done more than yourself in following the example of its leaders. On the present occasion I will only allude to the various Memoirs of the Geological Survey, especially that on the London Basin, in which you have taken so large and important a share, and will dwell rather on your contributions to our own Journal and to other publications. Your papers on the western end of the London Basin, and on the Lower London Tertiaries of Kent, deserve to be ranked with the classic memoirs of Prestwich as elucidating the geology of what I may call the Home District; and your last contribution to its deep-seated geology is still too fresh in our memories to need more than a mention. We do not forget your varied and valuable contributions to the Geological Magazine, especially those on the Red Chalk of Norfolk, on the Water-supply from the Chalk, on the formation of the Chesil Bank (written jointly with Mr. Bristow), a paper, as it seems to me, of remarkable suggestiveness, and last, but by no means least, "On Subaerial Denudation," in which, as remarked by the late Mr. C. Darwin, you had "the good fortune to bring conviction to the minds" of your fellow-workers by means of "a single memoir."

We are also greatly indebted to you for your labours in reference to the history of the literature of geology, a task involving not a little labour, which, though of the greatest value to students, is to all unremunerative and would be, to many, exceptionally toilsome. Of this, your care for several years of the Geological Record, and the lists of books and memoirs relating to the geology of various counties in England, are conspicuous instances.

There is a peculiar appropriateness in the award to you of this Medal, founded by Sir Roderick Murchison, one of the illustrious chiefs of your Survey, and I have the greatest pleasure, on behalf the Council of the Geological Society, in placing it in your hands together with the customary grant from the Fund.

Mr. Whitaker, in reply, said that to workers in science the best reward was the appreciation of their fellow-workers, and of this he had on various occasions received testimonies; but the award of this Medal was the crowning one, knowing, as he well did, the care with which such awards were made. He expressed his interest in the Geological Survey, to which he had for so many years belonged, and in the important work done by his colleagues in that Survey. He had a particular pleasure in receiving this award from the hand of an old friend like the President, whom he thanked most heartily for the very kind and flattering terms employed by him in presenting the Medal. He also thanked the Fellows of the Society present for the cordial manner in which they had received the announcement of the award.

In presenting the Balance of the Proceeds of the Murchison Geological Fund to Mr. Clement Reid, F.G.S., the President said:—

Mr. Clement Reid,—The later Pliocene and the Pleistocene deposits of East Anglia offer to geologists a series of problems as difficult as they are attractive. We are indebted to you for much valuable information on the exact distribution and the fossil contents of these varied deposits, which owing to peculiar local circumstances often present exceptional difficulties, and demand exceptionally patient study on the part of the investigators. Your memoir on the Forest Bed of Norfolk is a contribution of especial value to students as affording them fuller and more precise information than could previously be obtained, while the pages of our Journal and of the Geological Magazine testify to the zeal and thoroughness with which you have applied yourself to these and kindred questions. In conferring upon you this award from the Murchison Fund, which I have great pleasure in placing in your hands, the Council of the Geological Society hopes that it may aid you in prosecuting your studies in this department of geology and extending them to localities which could not be visited by you in the discharge of your professional duties as a Member of the Geological Survey of Great Britain.

Mr. Clement Reid, in reply, said:—Mr. President,—I have sometimes felt discouraged at the small results of my work. But this welcome and unexpected award by the Council of the Geological Society is a recognition that the work is not considered altogether worthless, and will encourage me still to persevere. Though a large portion of my observations have been made in the course of the Geological

Survey, I have also devoted my leisure time to the study of various questions in Pleistocene and Pliocene Natural History. This award of the Murchison Fund will now enable me to undertake a more thorough examination of many of the less-known deposits.

The President next presented the Lyell Medal to Mr. William Pengelly, F.R.S., F.G.S., and addressed him as follows :—

Mr. Pengelly,—The Council of the Geological Society has awarded you the Lyell Medal and a sum of twenty guineas from the Fund in recognition of your lifelong labours in the cause of geology, and more especially of your investigations in those caverns of the south-west of England by means of which our knowledge of the condition of Britain during the latest epoch of geological history has been so largely augmented. To exhume the contents of a cavern, not only the lair of wild beasts, but also an abode of men in those ages when, to quote the words of the old Greek tragedian,

"Like tiny ants they dwelt in sunless caves," [1]

requires the exercise of unwearied patience and, in addition, of extensive knowledge and critical acumen. By the labours of the Committee, of which you were the hands and the eyes, and at least a fair proportion of the compound brain, Mr. MacEnery's long-neglected discovery in Kent's Hole was placed beyond all dispute, and the contents of that cavern, its succession of deposits, its relics of extinct animals, and its tools of stone and bone, denoting more than one stage of civilization, have been made known to the world.

In like way the virgin ground of the Brixham cave was investigated, and its valuable contents have been rendered accessible to students. All this you have done, not as the fruit of secured leisure, but in the intervals of a busy life, of which, in the full sense of the words, time was money ; and you began this work at a period when, owing to mistaken prejudices, you incurred no small risk of obloquy and personal loss. Your work at Bovey Tracey and your papers on the later geology of Devonshire and Cornwall are too well known to need more than a passing allusion ; the Torquay Museum and the Transactions of the local societies will be a lasting monument of your zeal in stimulating scientific researches in the neighbourhood of your home. There is a peculiar fitness in the award to you of this Medal, a memorial of the fearless and illustrious author of the "Principles of Geology" and of the "Antiquity of Man." I esteem myself exceptionally fortunate in being commissioned to place it in your hands, and being thus enabled to testify my regard for so valued and genial a friend.

Mr. Pengelly, in reply, said that he could not conceal from himself, and did not wish to conceal from the Fellows, the gratification that he felt at receiving this award. He had studied Geology for some fifty years, although he had appeared but little in the rooms of the Geological Society, his publications on geological subjects having been chiefly contributed to those local Societies in whose neighbourhood his researches had been carried on. His gratification at this award compensated for much obloquy, especially as it bore the name of an old and loved friend with whom he had worked much and often. No doubt the founder of the Medal intended that its award should serve not only as a reward for work done, but as a stimulant to further exertion. It came to him so late in the day, however, that he could hardly hope to do very much more ; but although he himself might not be urged by it to renewed efforts, the stimulus might act vicariously, as the knowledge that he had received this recognition of such services as he had rendered to science would doubtless get spread abroad in Devonshire, and would probably serve as an incitement to many local workers to persevere in their studies.

In handing the Balance of the Proceeds of the Lyell Donation Fund to Dr. Henry Woodward, F.R.S., F.G.S., for transmission to Mr. D. Mackintosh, F.G.S., the President addressed him as follows :—

Dr. Woodward,—I have much pleasure in placing in your hands, as representing Mr. Mackintosh, the balance of the Lyell Donation Fund awarded to him by the Council of the Geological Society. In him we have a second instance of the way in which, through an untiring zeal for science, the rare intervals of a hard-worked life

[1] Æschylus, Prom. Vinct. 491.

may bear fruit so largely augmenting the common stock of geological knowledge. There are few problems more interesting than that of the physical condition of our native land during the period commonly designated the Glacial Epoch; but for its solution an exact knowledge of the distribution of erratics and an identification of their points of departure is absolutely necessary. Those who, like myself, have attempted to adjust the rival claims of glacier and floe, of the ice-chariot *versus* the ice-ship, as vehicles of boulder-transport, can hardly speak too highly of the value of the papers on British erratics which he has contributed to our Journal and to other publications. I trust that this award may not only be gratifying to him as a mark of our appreciation, but also help him in continuing his labours in a field where, notwithstanding them, much still remains to be done.

Dr. Woodward, in reply, said:—Mr. President,—The intelligence of the decision of the Council has had a most cheering effect on Mr. Mackintosh, and will brighten the remaining years he may have left to him. It is well known to Fellows of this Society what has been the nature of Mr. Mackintosh's work, and what good and careful observations he has made, extending over long years of wandering up and down through England and Wales, and carefully observing wherever he went. I cannot do better than read the following letter from Mr. Mackintosh, which, indeed, is addressed to yourself. He says:—"In thanking you for the honour conferred upon me by the Award of the Lyell Donation Fund, I may mention the fact that 25 years ago I was elected a Fellow of this Society, and that Sir Charles Lyell was one of those who signed my certificate. I am now seventy years of age; this is the second occasion that my work has been so much honoured, for I am proud to be able to state that I was presented with the Kingsley Medal of the Chester Society of Natural Science in 1881."

The President them handed the Award from the Barlow-Jameson Fund to Dr. W. T. Blanford, F.R.S., for transmission to Dr. H. J. Johnston-Lavis, F.G.S., and addressed him as follows:—

Dr. Blanford,—I will ask you to transmit this Award to Mr. Johnston-Lavis. In this country happily the volcanic fires have long ceased to glow, and the earthquake seldom causes more than a transient tremor. It is otherwise on the shores of the Bay of Naples, where again and again during the last eighteen centuries Vesuvius has rained down ruin; and of late years the earthquakes of Ischia have wrought destruction on the works, and desolation in the homes, of men. It is true that these phenomena of the darker side of nature have not been unobserved by the many illustrious men of science to whom Italy has given birth; but "the curse of Babel" has debarred some of us from access to their works. This alone gives an exceptional value to the elaborate studies which Mr. Johnston-Lavis has undertaken of the various eruptive-products of Vesuvius, and of the Ischian earthquakes. There is yet another advantage, that natural phenomena should be studied by men of different nations, diverse training, and varied habits of mind. In recognition of his past labours and in furtherance of future work in the vicinity of Naples, the Council has awarded to him a grant from the Barlow-Jameson Fund, which I have much pleasure in placing in your hands.

Dr. Blanford, in reply, said that the best mode of replying to the kind remarks made by the President would be to read a letter which he had received from Dr. Johnston-Lavis. That gentleman said:—

"It was with a considerable amount of astonishment and pleasure that I received your letter announcing the Grant from the Barlow-Jameson Fund, since the news was so perfectly unexpected. The honour thus paid me for my attempts to clear up some questions in vulcanology and seismology will stimulate me to further follow that line of investigation, with the hope of adding something more to our knowledge of those subjects.

"My professional work at this season prevents me from having the great pleasure of being present in person to receive this mark of esteem from the hands of our President. Will you kindly express my deep gratitude to the Society for so generously conferring such an honour upon me."

The President then read his Anniversary Address, in which, after giving obituary notices of some of the Members lost by the Society during the year 1885, he referred to the principal contributions to

geological knowledge which have been made during the past year, both in the publications of the Society and elsewhere in Britain. The remainder of the address was devoted to a discussion of the principles of nomenclature which should be followed in regard to the metamorphic rocks. After describing the nature and relations of the various metamorphic rocks in certain parts of the Alps, Canada, Scotland, etc., the effects of the intrusion of igneous rocks, and the results of pressure in producing changes, both mechanical and chemical, upon rocks originally crystalline, he pointed out that these last could generally be distinguished from anterior foliation, otherwise produced; that many rocks in the metamorphic series appear to have originated in stratified deposits, but that the evidence at present in our possession pointed to the very great antiquity of all these, and to the probability of their having been produced under conditions which have not recurred since the beginning of the Palæozoic period.

The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President*: Prof. J. W. Judd, F.R.S. *Vice-Presidents*: H. Bauerman, Esq.; John Evans, D.C.L., LL.D., F.R.S.; A. Geikie, LL.D., F.R.S.; and J. A. Phillips, Esq., F.R.S. *Secretaries*: W. T. Blanford, LL.D., F.R.S.; and W. H. Hudleston, Esq., M.A., F.R.S. *Foreign Secretary*: Warington W. Smyth, Esq., M.A., F.R.S. *Treasurer*: Prof. T. Wiltshire, M.A., F.L.S. *Council*: H. Bauerman, Esq.; W. T. Blanford, LL.D., F.R.S.; Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.; Thomas Davies, Esq.; Prof. P. Martin Duncan, M.B., F.R.S.; John Evans, D.C.L., LL.D., F.R.S.; A. Geikie, LL.D., F.R.S.; Henry Hicks, M.D., F.R.S.; G. J. Hinde, Ph.D.; J. Hopkinson, Esq.; W. H. Hudleston, Esq., M.A., F.R.S.; Prof. T. M'Kenny Hughes, M.A.; Prof. T. Rupert Jones, F.R.S.; Prof. J. W. Judd, F.R.S.; R. Lydekker, Esq., B.A.; J. E. Marr, Esq., M.A.; J. A. Phillips, Esq., F.R.S.; Prof. H. G. Seeley, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; J. J. H. Teall, Esq., M.A.; W. Topley, Esq.; Prof. T. Wiltshire, M.A., F.L.S.; Henry Woodward, LL.D., F.R.S.

II.—Feb. 24, 1886.—Prof. J. W. Judd, F.R.S., President, in the Chair.—The following communications were read:—

1. "On two Rhætic Sections in Warwickshire." By Rev. P. B. Brodie, M.A., F.G.S.

The sections noticed in this paper were (1) one exposed on a railway at Summer Hill, near Binton, between Stratford and Alcester, and (2) one, 13 miles further to the south-east, at Snitterfield, three miles north of Stratford-on-Avon, in excavations for a tunnel connected with a supply of water to that town.

At the first-named locality a bed with insect remains overlies the firestone and *Estheria*-bed, and this is succeeded in descending order by a considerable thickness of black and grey shales with the usual Rhætic fossils. The bone-bed is not exposed.

At the second locality, in borings and shafts, black Rhætic shales were found in three places resting upon a denuded surface of new Red Marl, and covered by between 40 and 50 feet of drift. *Avicula contorta* and other typical fossils were obtained from the shales. In other shafts the Rhætic beds were wanting, so that apparently those met with were merely small portions remaining of a larger mass which had been denuded away.

2. "On the Basement-beds of the Inferior Oolite of Gloucestershire." By E. Witchell, Esq., F.G.S.

The author observed that few papers have appeared lately on this subject in the Quarterly Journal, and admitted that the work done between 1847 and 1860 was of such excellent character that there seemed to be but little left to do in the Cotteswolds. Still he considered, after twenty-five years of experience, that there is room for another paper on the lower beds:—

(1) Because the Pea Grit of Leckhampton is made to include too much.

(2) Because this use of the term has led to confusion.

(3) Because the Pea Grit proper has a greater extension than has hitherto been supposed.

Thus has arisen the mistaken notion that the Oolitic limestone at Frocester and Haresfield Hills is part of the freestone series *above* the Pea Grit. The author proposed to call the beds underlying the Pea Grit the "Lower Limestone," and gave sections at Crickley Hill and Ruscombe, near Stroud, in explanation of his views.

Summarizing the results—(1) The Pea Grit is well developed in the Cheltenham area, thinning towards the south, is no more than from three to five feet thick in the Stroud area, extending as far as Uley Bury, where it occurs as a thin band, having lost its ferruginous aspect. (2) Underlying this are several beds of white Oolitic Limestone, having layers of freestone alternating with layers of shelly detritus, and locally small quartz-pebbles, thickness from 20 to 30 feet. Attention was especially drawn to the contrast which these beds present, both lithologically and palæontologically, to the Pea Grit; and to their poverty in entire organic remains, limited chiefly to a few very small and peculiar Gasteropods. (3) Brown sandy limestones, locally coarse ferruginous gritty beds from 5 to 9 feet, fossiliferous in the lower portion. These are within the *Opalinus*-zone, and repose directly on the Cephalopod-beds.

3. "On the Pliocene Beds of St. Erth." By Percy F. Kendall, Esq., and Robert G. Bell, Esq., F.G.S.

This paper consisted of a description of the beds exposed at St. Erth, a list of the Molluscan fossils identified, and some preliminary considerations of the evidence afforded by the Mollusca, and may be considered a continuation of that by the late Mr. S. V. Wood, read to the Society in November, 1884.

The beds consist of sand and clay dipping to about 5° to N.N.W. The only important fossiliferous bed is a blue clay, and fossils have only been obtained in one spot, though the beds have been traced over an area of about 120 acres. The fossils are well preserved, and with a few unimportant exceptions, are of invertebrate forms, chiefly Mollusca, Polyzoa, Ostracoda, and Foraminifera; remains of Crabs, Cirripedes, Echinoderms, Annelida, Sponges, and even of Holothurians and Tunicata (*e.g. Leptoclinum tenue?*) have been detected.

The list of the Mollusca showed the range of each species in Miocene and Pliocene beds and in the present seas. The authors considered that the fossils agree in age with the middle or lower

portion of the Red Crag, but that whilst many species having a southern character are present at St. Erth, and wanting in the Crags of the East coast, the Boreal and Arctic forms found so abundantly in the Crag are absent at St. Erth.

In explanation of this remarkable fact, it is suggested that when the St.-Erth beds were deposited, although the North-Sea area was in direct communication with the Arctic Ocean, the western part of the British Channel was not, that the British Isles were joined to the continent of Europe on one side and to Greenland on the other, the Shetland and Faroe Islands and Iceland being the remnants of the barrier that formerly divided the Atlantic from the Arctic Sea. Evidence is given in support of this view from the present submarine configuration of the North Atlantic. It was also shown to be probable that the St.-Erth area, in Pliocene times, was more directly connected with the Mediterranean than at present, by a marine channel that traversed France.

III.—March 10, 1886.—Prof. J. W. Judd, F.R.S., President, in the Chair.—The following communications were read:

1. "On the Alteration of coarsely spherulitic Rocks." By Grenville A. J. Cole, Esq., F.G.S.

The author stated that the pitchstone of Zwickau, Saxony, contains large spherulites, remarked on by Cotta in 1847, which are devoid of radial structure, and are traversed by the fine lines of flow that characterize the glassy matrix. The centre of each of these has been hollowed out by decomposition along cracks, as may be seen at the ends of the branches into which the cavity divides, and infiltration of chalcedony and calcite has occurred. The lines of flow correspond on opposite sides of this secondary mass, and do not bend round as if the spherule had formed about some calcareous inclusion or about a vesicle. Similar excavation and infiltration have occurred extensively among the coarsely spherulitic layers of the Precambrian rhyolites of Lea Rock, Wrekin, and in these the cracks traversing the rock are seen, under the microscope, as mere lines when passing through the matrix, but widen out at once probably through more ready decomposition along their walls, when they enter spherulitic matter. In the white rock (Silurian rhyolite) of Digoed, near Penmachno, N. Wales, similar alteration has converted the closely set spherulites (often three inches in diameter) into mere shells filled with quartz and chlorite; while a black slate-like decomposition-product, with a hardness of 2·5 and a specific gravity of 2·77, occurs occasionally here, and very frequently in the less coarse but similar rock of Conway Mountain. In the latter place spherulites may be found containing this product in alternate concentric layers. Analysis shows it to be allied to pinite; but the formation in it, when it tends to become crystalline, of microlites of various kinds, opposes its being regarded as a simple mineral. The rock of Digoed itself contains 83 per cent. of silica, the black product only 50 per cent. The great nodular masses of quartz and these contrasted soft, black, cleavable layers form striking features of alteration, especially as

the residual spherulitic matter closely resembles the matrix, and may in time become undistinguishable from it. A consideration of the pyromerides of the continent makes it appear probable that they also are altered coarsely spherulitic rhyolites, and the comparisons made by Delesse in 1852 strongly support this view.

2. "Account of a Well-sinking made by the Great Western Railway Company at Swindon." By Horace B. Woodward, Esq., F.G.S. With Lists of Fossils, by E. T. Newton, Esq., F.G.S.

This well-sinking was made under the direction of Captain William Dean, while fossils were collected and notes of the strata were made by Messrs. W. H. Stanier and A. R. Elliott, to whom the authors were greatly indebted. The object of sinking was to seek a supply of water for use in the works at Swindon. The strata proved were as follows:—

	ft.	in.
Made ground	8	0
Kimmeridge Clay	64	1
Corallian Beds	40	1
Oxford Clay and Kellaways Rock	572	9
Cornbrash	18	3
Forest Marble	33	0
	736	2

Unfortunately for the Company, saline waters were met with in the Corallian rocks, and again in the Forest Marble.

Few fossils were obtained from the Kimmeridge and Corallian rocks; but those from the Oxford Clay and Kellaways Rock indicated the upward succession of the Callovian *ornatus*- and *cordatus*-forms of Ammonites. It was shown that at least 44 feet of clays, sands, and sandstones might be assigned to the Kellaways Rock, which should be regarded as an irregular and impersistent basement-bed of the Oxford Clay. Turning to the subject of the saline waters, it was shown from analyses by Mr. F. W. Harris that the Corallian water contained 144 grains per imperial gallon, consisting chiefly of sodium chloride and sodium carbonate. In the Forest-Marble water, which had a temperature of 64°, the saline ingredients amounted to 2131 grains per gallon, consisting chiefly of sodium chloride, calcium chloride, etc.

Attention was then drawn to the occurrence of saline waters in the Jurassic rocks, at Melksham, Holt, Trowbridge, St. Clement's, Oxford, and other localities in the neighbourhood; and also to the occurrence of saline waters in the Coal-measures and older rocks of the Bristol Coal-basin, etc. It was shown that the occurrence of saline waters was not necessarily connected with the proximity of saliferous New Red rocks, and it was suggested that the saline waters at Swindon escaped from a ridge of Palæozoic rocks against which the Lower Jurassic rocks abutted, as they do on the Mendip Hills.

Mr. E. T. Newton said the fossils had been collected with great care by Mr. Stanier and Mr. Elliott, an exact record of depths being kept. He noticed some of the more important species that had been met with and their distribution, especially mentioning that the Ammonites from the Oxford Clay were nearly all from greater depths than 400 feet.

CORRESPONDENCE.

THE GEOLOGICAL AGE OF THE NORTH ATLANTIC OCEAN.—REPLY OF PROFESSOR HULL TO PROFESSOR LE CONTE.

Sir,—I have read with much pleasure Professor Le Conte's views on the question of the "Permanence of Continents and Ocean-Basins"; and especially with reference to the growth of the North American Continent.[1] I am glad that he does not carry his views as far as some geologists on this question. As stated, they are substantially the same as those supported in his "Elements of Geology" (Edit. 1885). It seems to me, however, that Prof. Le Conte scarcely realizes sufficiently what must have been the effect of continued subsidence during the whole of the Palæozoic period in extending the sea-area, and consequently in pushing the adjoining land-area further into that of the present North Atlantic Ocean. In his ideal-section (*Elem.* p. 288) of the Palæozoic rocks from the Primordial downwards to the Carboniferous, which is consistent with his statement that the whole of these rocks in the United States are conformable, Prof. Le Conte makes it clear that were these strata reduced to the original horizontal position, there would be several thousand feet of marine sediments, which must originally have overlapped on the flanks of the lands formed of Archæan rocks. This will, probably, explain to him why in my sketch-map No. 2 I have carried the northern part of the continental border westward so as to cut through Labrador, not in "Primordial times," as he supposes, but in Silurian times, when the land-area was further depressed.[2]

I am gratified to find that on the question of the position of the and and sea areas during Archæan (or Laurentian) times Prof. Le Conte is in accord with myself; on the other hand I fully agree with him as to the immense duration of the "Lost Interval" which elapsed between the Archæan and Primordial eras, and the extent of the denudation of the raised sea-beds over the American and European continents. But, I cannot concur with him in supposing that the small tracts of land which were (at least partially) maintained in the North, as the Laurentian "Nucleus," or along the East of the Appalachians (even with a considerable margin including some now ocean-covered tracts), were sufficient to supply the amount of Palæozoic sediment, which, *when originally deposited* (*i.e.* before denudation), was the measure of the denudation of these tracts themselves. The conformable relations of these beds throughout a vertical depth of several thousands of feet imperatively involves the view of the contemporaneous existence of an extensive continental area, stretching both to the north and east of the present margins of the Silurian strata. Nor, as it appears to me, does Prof. Le Conte recognize sufficiently (if at all) the significance, in reference to this question, of that on which I have laid principal stress in my essay; namely,

[1] Geological Magazine, March, 1886, p. 97.
[2] Scient. Trans. Roy. Dublin Soc. vol. iii. new ser. plate vii. p. 319.

the increase in thickness of the sedimentary strata towards the north-east and east of the N. American continent, and their attenuation and replacement by limestones in opposite directions. In the case of these sediments they are truncated along their thickest margins; and the fact, which I have pointed out, that the British and European formations exhibit similar phenomena of attenuation and truncation, only in an opposite direction, leads us to a similar conclusion with reference to the position of the derivative lands. Prof. Le Conte admits (p. 100) that the great thickness of Carboniferous strata would require a large land-mass to the east of the Appalachian region; but, he adds, "There is no reason why the eastern land-mass, which sufficed to contribute 30,000 feet of Silurian and Devonian sediments, should not have been sufficient to contribute the much smaller amount of sediments of the Carboniferous period." This, however, allow me to say, is begging the question at issue between us. I maintain in the first place, that the narrow strip of land (comparatively speaking) allowed by Prof. Le Conte was quite insufficient for the production of 30,000 feet of conformable sediments; and secondly, that this continuous accumulation of such sediments must have caused the originating land-mass to recede farther and farther eastwards into the Atlantic area, down to the close of the Carboniferous (or Permian) epoch.

Prof. Le Conte is scarcely correct in stating, that in my map, fig. 3, I have completely abolished the Atlantic Ocean by converting it into land during the Carboniferous epoch. As a matter of fact, I have indicated the land as far south as lat. 38°—40°, making it intentionally vague at this line. As will be seen, on referring to the map itself, the main land-areas are represented as occupying the Arctic regions; and there is an interesting fact tending to corroborate the view of the land connection between Europe and America during both Devonian and Carboniferous times which should not be lost sight of, viz. the general resemblance, and partial identity, of the land floras of both regions during these epochs. Altogether it would appear that there is cumulative evidence of the general correctness of the views I have endeavoured to enunciate, whether we have recourse to the organic or physical aspects of the question.

EDWARD HULL.

OBITUARY.

CHARLES WILLIAM PEACH, A.L.S.

BORN 1800. DIED 1886.

CHARLES W. PEACH, Geologist and Naturalist, was born in 1800 at Wansford in Northamptonshire. His father was a harness-maker. He first went to a dame's school in the village, and at the age of twelve was sent to a school at Folkingham in Lincolnshire, where he remained three years. He was appointed to a post in the Revenue Coastguard in January, 1824, and sent first to Southrepps in Norfolk, and afterwards to Weybourn, Cromer, etc. Here he first commenced

the study of Natural History, and began to make a collection. He made the acquaintance of the Rev. J. Layton, then living at Catfield. With this excellent geologist he explored the cliffs and the submerged Forest-bed, and assisted him greatly in collecting the large series of teeth and bones of elephants which are now preserved in the British Museum.

From Norfolk Peach was sent to Lyme Regis and Charmouth in Dorsetshire, and thence into Cornwall, where he worked at the geological formations along the coasts, and found fossils where no fossils had been found before. At the meeting of the British Association held at Plymouth in 1841, he read his first paper entitled "The Organic Fossils of Cornwall." The following year at the Manchester Meeting he read a paper before the Zoological Section, "On the Marine Fauna of the Cornish Coast." Charles Darwin, in his monograph on the *Balanidæ* (Ray Society, 1854, p. 157), quotes Mr. Peach's observations on the exuviation of the integument of the *Balani* on the Cornish coast. He was acknowledged to be one of the most original observers in Geology and Zoology, and was taken by the hand by Murchison, De la Beche, Buckland, Forbes, Daubeny and Agassiz.

While residing at Fowey, he was made an Honorary Member of all the local scientific Societies of the Duchy, and he added many organic remains from the Devonian rocks to the collection of the Royal Geological Society of Cornwall, and this collection seems to have remained as he left it nearly 40 years ago.

One of Peach's most important discoveries was the detecting remains of Pteraspidian fish-shields, in the Lower Devonian Slates of Polperro in Cornwall. These fossils were recognized as fish by Mr. Peach in 1843. In 1851 Prof. McCoy determined the fossil to be a *Sponge*! and named it *Steganodictyum Cornubicum*. Prof. Ferdinand Roemer subsequently determined it to be the bone of a Cuttle-fish, and named it *Archæoteuthis Dunensis* (1855); and in 1868 Prof. Ray Lankester, in a note to the Geological Society, stated that Huxley and Salter, as well as himself, had determined it to be the cephalic plate of a Pteraspidian fish (Quart. Journ. Geol. Soc. 1868, vol. xxiv. p. 546), which he described under the name of *Scaphaspis Cornubicus*. He says, "The merit of first recognizing the fish-nature of these remains belongs to Mr. Peach, who more than twenty years since wrote of them as such" (*op. cit.* p. 547). See also Geol. Mag. 1868, Vol. V. pp. 247–248, and 1869, Vol. VI. pp. 77–78. Mr. Pengelly, writing on the same subject, says:—"Mr. Peach's judgment has received the fullest justification, and we all congratulate him heartily on the fact" (Trans. Devonshire Assoc. for 1868).

Having been transferred from the Coast-guard to the Customs, Peach was removed from Cornwall to the north of Scotland, being stationed first at Peterhead, and afterwards at Wick. It was whilst at the latter place that he made the acquaintance of Robert Dick, the Thurso Baker-Geologist and Botanist, and the account of their friendship and mutual studies is contained in some of the most interesting chapters in Dr. Smiles' "Life of Robert Dick," part of

which book is devoted to a biographical sketch of Mr. Peach, to which we are indebted for many of our facts. Here he continued his study of geology and zoology. Whilst travelling round the coast of Caithness in search of wrecks, he made good use of his spare time, hammering the rocks in search of fossil plants with which the dark flagstones of the district abounded. He was the first to find fossils in the limestones of Durness in Sutherland. Obscure organic remains had been detected by Macculloch in the quartz rocks of Sutherland; but they passed out of mind, and their organic nature was stoutly denied by Sedgwick and Murchison. Peach, however, in 1854 brought to light a good series of shells[1] and corals, which demonstrated the limestone containing them to lie on the same geological horizon as some part of the Lower Silurian of other regions. He also found a new fossil fish, which was described in the Decades of the Geological Survey. At the meeting of the British Association at Liverpool, 1854, Peach read a paper on "The Remains of Land Plants and Shells in the Old Red Sandstone of Caithness." In August, 1858, Mr. Peach accompanied Sir R. I. Murchison to the Orkney and Shetland Islands, and finally the two geologists landed at Cape Wrath, and proceeded to visit the Durness Limestone, where all that Peach had already discovered was confirmed by the personal observation of Sir Roderick, who, proceeding to Leeds, laid before the Geological Section of the British Association, "The Results of his Researches among the older rocks of the Scottish Highlands," doing full justice to Mr. Peach's discovery of organic remains of the Lower Silurian age in the Crystalline Limestone of Sutherland, similar to those which occur in the Lower Silurian rocks of North America.

He was a Fellow, and served the office of President of the Royal Physical Society of Edinburgh.

In 1868 Peach was elected an Associate of the Linnæan Society of London.

The "Neill Gold Medal" was awarded to Mr. C. W. Peach in 1874, by the Royal Society of Edinburgh, for the addition of about 20 species of *Echini*, *Medusæ*, and *Sponges* made by him to the known fauna of the British seas.

Though his long and active life had entitled him to rest both from official and scientific work, his vigorous mind and great love for science urged him to further investigations, and in the plant-bearing beds of Edinburgh, Falkirk, and Fife, he made important discoveries, not only of new forms of plant-life, but of materials which increased our knowledge of already described forms.

He died at 30, Haddington Place, Edinburgh, on February 28th, in his 86th year. His son, Mr. B. N. Peach, F.R.S.E., F.G.S., has for many years been attached to the Geological Survey of Scotland, and is the author of several important geological and palæontological memoirs.

[1] *Maclurea Peachii*, which was named after Mr. Peach, and several other forms.